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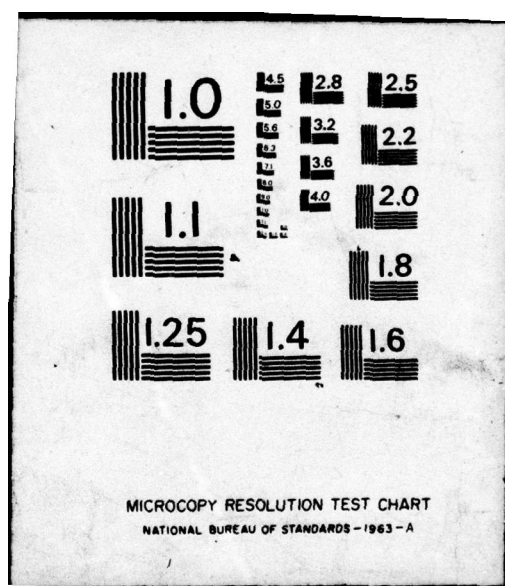
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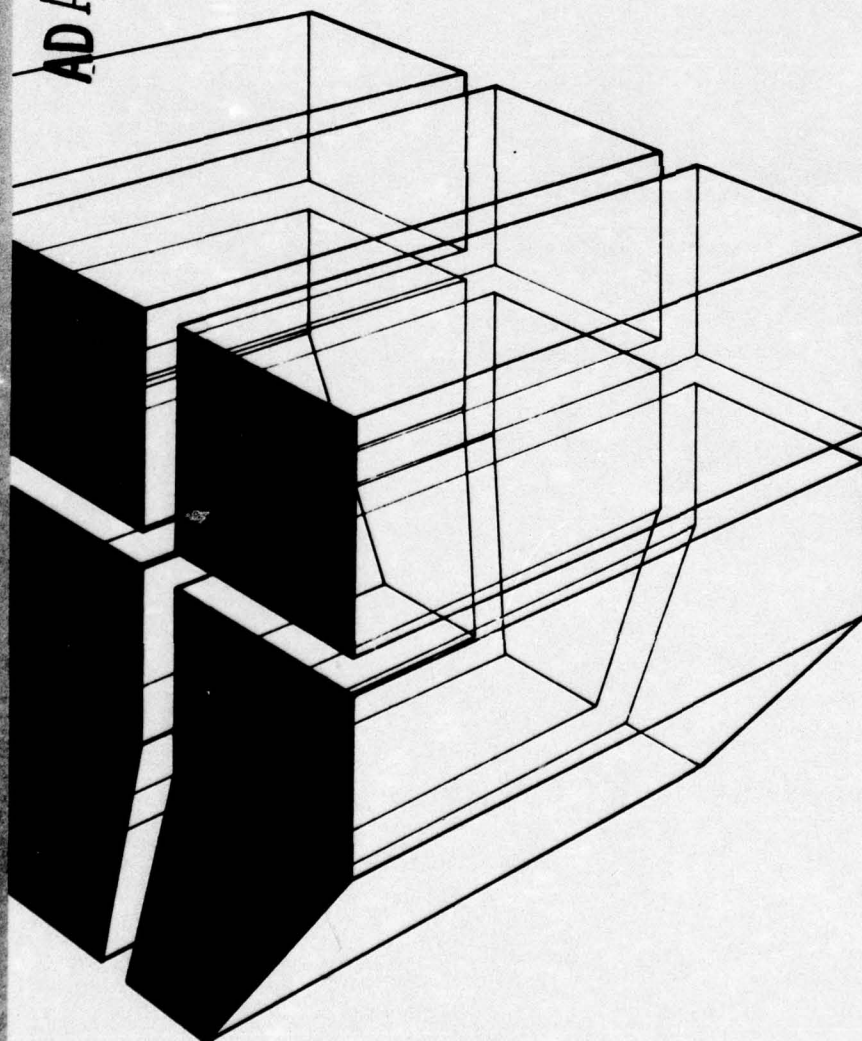
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TECHNICAL REPORT D-74  
December 1976  
Systems Approach to Site Development

ADA 034167

SITE CONCEPT PLAN DEVELOPMENT MANUAL  
FOR FAMILY HOUSING

by  
T. R. Napier  
A. W. Moore



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## FOREWORD

This research was conducted for the Directorate of Military Construction, Office of the Chief of Engineers (OCE), under project 4A763734DT08, "Military Construction Engineering Development," Task 03, "Military Housing," Work Unit 001, "Systems Approach to Site Development." The OCE Technical Monitor was Mr. D. Swanson.

The study was conducted by the Master Planning and Systems Building Branch (HPM), Habitability and Planning Division (FH) of the U.S. Army Construction Engineering Research Laboratory (CERL). Dr. D. G. Bagby is Chief of HPM and Dr. R. M. Dinnat is Chief of FH.

COL J. E. Hays is Commander and Director of CERL and Dr. L. R. Shaffer is Technical Director.

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# SITE CONCEPT PLAN DEVELOPMENT MANUAL FOR FAMILY HOUSING

## 1 INTRODUCTION

### Purpose

This document prescribes activities, procedures, and planning considerations necessary for preparing site design for military family housing. It is directed primarily to district personnel and prospective contractors and supplements Office of the Chief of Engineers (OCE) engineering instructions issued for each "turnkey" family housing project.

### Scope

This document details operations necessary for complete user satisfaction, environmental appropriateness, and cost reduction in developing site designs. Specifically, it includes the following information:

- a. OCE and Department of Defense (DOD) instructions and criteria
- b. Prerequisite master planning activities and studies
- c. Site analysis activities
- d. Facility requirements and design criteria

- e. Design evaluation criteria.

This report covers operations performed in the third phase of the process of providing military family housing (Figure 1).

### Limitations

The variety of environmental considerations throughout the United States precludes establishing a family housing site concept development manual which presents and evaluates all local conditions. Therefore, this document presents only those design criteria and standards applicable to all geographical locations.

### Design Collaboration

The prospective turnkey contractor must insure adequate in-house collaboration among all phases of site design and engineering. The dwelling unit architect must be aware of relationships external to the dwelling unit, as must the site designer be aware of the internal relationships of the dwelling units. Favorable internal/external relationships are essential for high quality site design and avoidance of conflicts between dwelling units and other site activities.

Close collaboration among the site planner and other engineering professions such as civil, electrical, and sanitary engineers is also necessary to insure a well-integrated and efficient plan.

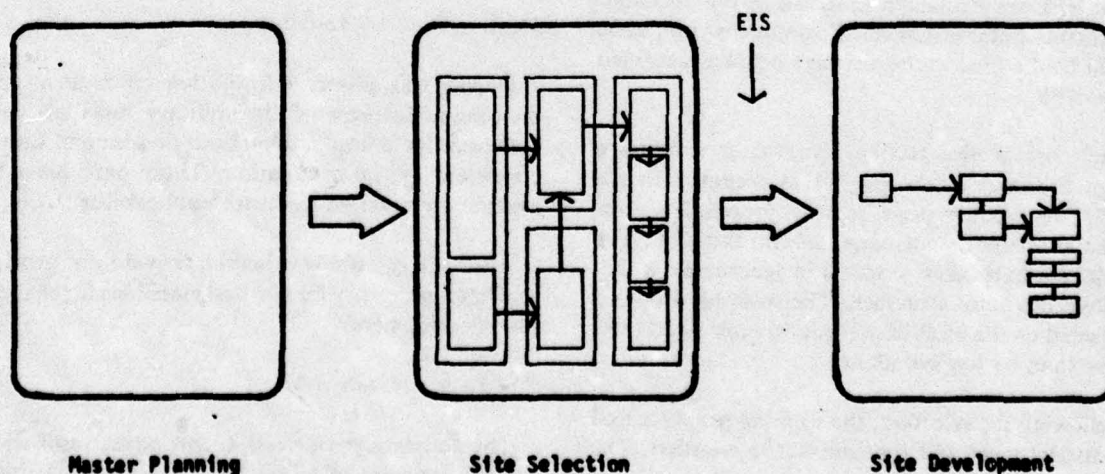


Figure 1. Family housing process.



## 2 PREREQUISITE ACTIVITIES AND INSTRUCTIONS

### General

Both DOD and OCE have control over what facilities are designed at military installations and how they are designed. DOD provides guidance to the Army on the design of military family housing through two documents—the *DOD Design Folio*<sup>1</sup> and the *DOD Construction Criteria Manual*.<sup>2</sup> The Department of the Army, through OCE, develops and issues detailed design criteria and procedures for facility design and construction which are consistent with, but more definitive than, the policy statements and criteria in the DOD manual.

For a specific project, the Corps district issues specific design criteria and instructions to the prospective turnkey contractors through a Request for Proposal (RFP). This document includes contract information, price schedules, design criteria, and specifications. Further engineering instructions or design manuals may be made available as supplementary information. However, the material contained in the RFP package provides all required design and technical criteria.

Shortly after the issue of the RFP, the district conducts a preproposal conference. The purpose of this meeting is to explain the RFP and contract procedures to the prospective turnkey contractors. The contractual, technical, and administrative portions of the RFP are explained in detail at this meeting. Any further questions or clarifications that may arise should be directed to the district's contact identified in the RFP.

Each prospective turnkey contractor submits a design proposal to the district in response to the RFP. The bidding price for the proposal is submitted at a later date as stipulated in the RFP. The district evaluates each proposal in accordance with a quality/cost point structure. The winning proposer is selected on the basis of this quality/cost point ratio rather than on low bid alone.

Following the selection, the winning proposer and the district meet and the contract is awarded. The

district and the turnkey contractor review such matters as design approval and quality control at a predesign conference, after which the contractor proceeds with the completion of all final construction documentation. The district reviews progress on these documents at the 50 percent and 100 percent completion stages. A Notice to Proceed (NTP) may be issued by the districts contracting officer for any portion of or the entire project prior to or after final design approval upon satisfaction that the contractor has the proper technical and supporting resources.

### Previously Conducted Activities

Figure 2 illustrates the relationships among the various activities required for sound site concept plan development. The master planning activities identified in Chapter 2 of CERL's *A Site Selection Procedure for Military Family Housing*<sup>3</sup> represent the foundation on which all subsequent activities are structured.

Site concept plan development involves combining results of previous studies with information on the particulars of a site. Much of the required information has already been accumulated in the master planning and site selection phases. This information is then given to the prospective turnkey contractors to aid in design functions. After these data are analyzed, arrangements of structures in which all structures, systems, and elements of the land are in harmony are proposed. The most important previously conducted activities are summarized below.

#### Master Planning Activities

During this phase, information on natural and man-made features of the military installation is gathered, including data on both present and future conditions of the installation. These data must be continually updated to insure applicability.

Although extremely valuable, they do not provide the detail necessary for the best possible site concept plan development.

#### Site Selection Activities

The activities performed in this phase resulted in the development of an exclusionary map that indi-

<sup>1</sup>*Design Folio for Military Housing* (Department of Defense, May 1969).

<sup>2</sup>*Construction Criteria Manual*, DOD 4270.1-M (Department of Defense, October 1973).

<sup>3</sup>R. Reynolds and A. Moore, *A Site Selection Procedure for Military Family Housing*, Special Report D-67 (U.S. Army Construction Engineering Research Laboratory [CERL], 1976).

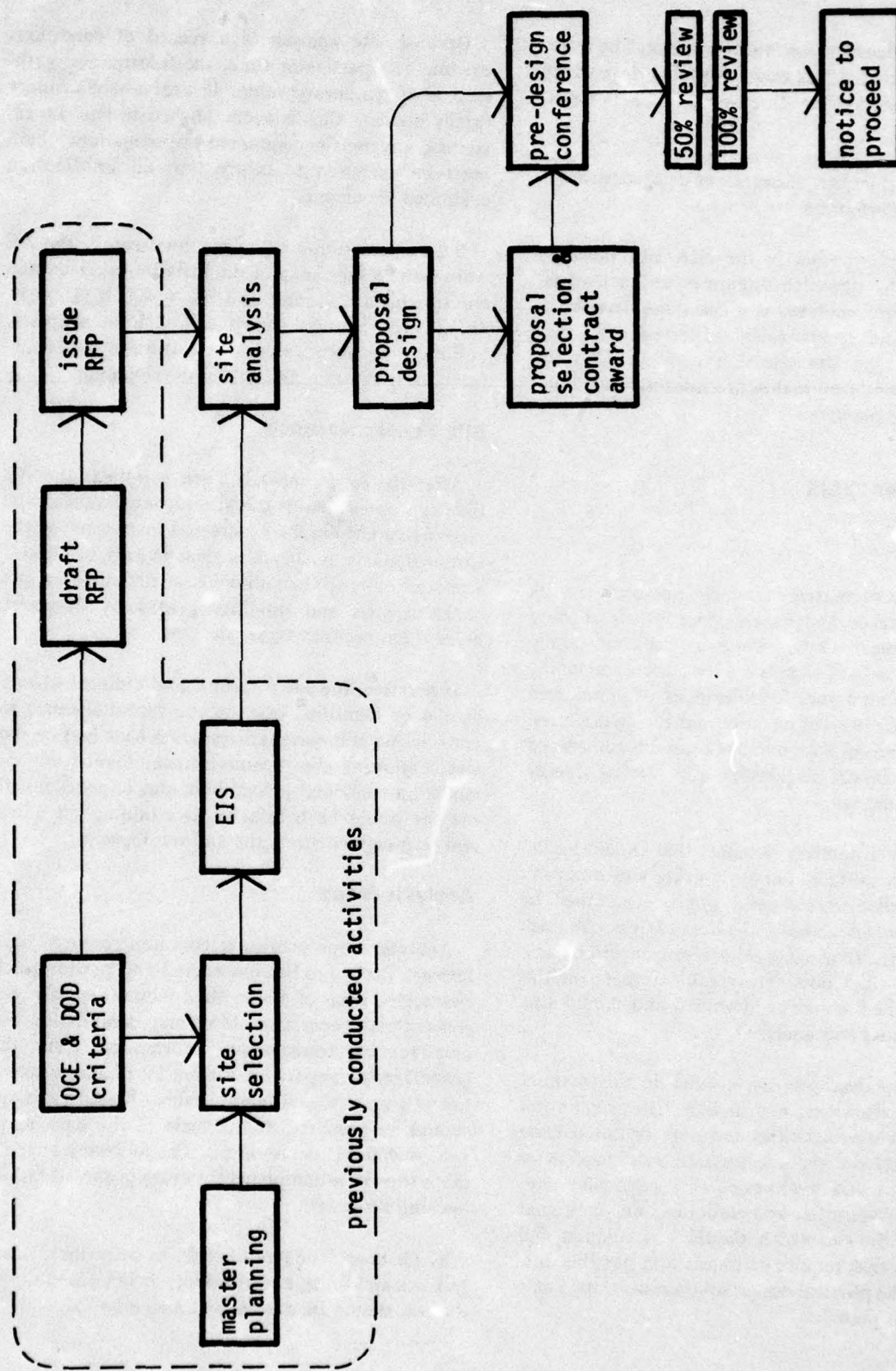


Figure 2. Concept plan development process.



cated an ideal location for family housing. The information generated at this stage identified data which should be expanded for effective site concept development.

#### *Environmental Impact Assessment or Statement (EIA/EIS) Information*

Since all information in the EIA/EIS must be documented by qualified engineers and scientists, the information generated is much more detailed in both scope and technological expertise than that generated in the site selection activity. This increased level of detail makes the information valuable to the site planner.

### **3 SITE ANALYSIS**

#### **General**

A site must be analyzed from two perspectives—its intended purpose and its existence as an ongoing natural system.<sup>4</sup> Thus, proposed military family housing sites must be analyzed for fitness for family housing and as natural communities of plants and animals. The intended purpose and the characteristics of the natural environment must be considered together to insure successful and lasting family housing site design.

This chapter itemizes elements that should be investigated in military family housing site analysis. All suggested elements need not be examined in detail at every site, since some items will not be relevant to particular geographic areas. Conversely, unlisted items that have considerable impact on the purpose of the site may be identified and should also be investigated and analyzed.

The site analysis process outlined in this manual uses information obtained in EIA/EIS preparation and site selection activities and data collected from supplemental site visits to prepare a description of the strengths and weaknesses of a particular site. The analysis identifies and elaborates on significant features of the site which should be exploited and notes areas that require emphasis and possible correction in the physical design solution developed as a site concept plan.

Because site analysis is a record of conditions existing at a particular time, the information gathered is of temporary value. If analysis of military family housing sites is accomplished in part by reviewing previously conducted investigations, care must be exercised to insure that all information examined is current.

Before performing a site reconnaissance, the AE will receive a base map of the installation. The map will be drawn at a scale of 1 in. = 400 ft (1 cm = 48 m). Information shown will include property, buildings, roadways, easements, utilities, land characteristics, climate, and future development.

#### **Site Reconnaissance**

After the base map has been supplied, the AE firm can proceed with the site reconnaissance. Site reconnaissance entails a personal inspection of the site to perceive its psychological impact or "feel." The sensitivity to the subtleties of the site's unique characteristics and qualities gained by designers helps them produce better designs.

If possible, the site's natural and cultural history should be identified prior to the reconnaissance to establish what impact various forces have had on the site. Following the reconnaissance, identifying installation residents' perceptions and impressions of the site would be helpful in ascertaining the site's real or imagined strengths and weaknesses.

#### **Analysis Maps**

Analysis maps provide a common resource base for each project to be constructed and permit quick characterization of a site, thus facilitating efficient concept plan generation. Most map compilation will only require transferring information from the general maps prepared in the master planning activities to a map of a different scale. All analysis maps should be prepared at the scale of the base map, 1 in. = 400 ft (1 cm = 48 m). The following analysis maps should be completed for every proposed family housing project:<sup>\*</sup>

a. **Geology.** The type of rock, its behavior characteristics and form, and the depth it is located under the soil should be determined and mapped.

<sup>4</sup>K. Lynch, *Site Planning*, Second Ed. (MIT Press, 1972), p 8.

<sup>\*</sup>Map categories are patterned after those in K. Lynch, *Site Planning*, Second Ed. (MIT Press, 1972), pp 92-93.

b. Soil. Data on the type and depth of soil, including its characteristics, value as a plant medium, and potential as engineering material should be included.

c. Water. Natural and man-made water features, including all lakes, streams, drainage channels, rivers, ocean frontage, etc., must be displayed on the map. In addition, flood plains and high water marks should be noted. Undrained depressions, blockages of drainage channels, or any unusual condition must also be indicated.

d. Topography. Slope analysis, slope orientation, and the pattern of land forms are the items of interest in this category.

e. Vegetation. Plant communities and individual specimen trees should be located and displayed to guarantee incorporation of vegetation into concept plans.

f. Man-Made Structures. Since existing structures both on- and off-site can have a significant impact on the site concept plan, the designer must recognize and note the impact of the built environment on the site and structure development concepts. For example, if many tall structures intrude on the design area, their impact on various locations of family housing should be considered and evaluated.

Existing on-site structures must be surveyed to determine if they can be used to store building materials during construction, or if they can be left intact and incorporated into the final design. Significant shadow patterns of surrounding buildings should be noted and their consequence on design identified.

Overhead utility standards, poles, and lines must be identified and their visual impact assessed.

The location, elevation, and capacity of utilities (storm and sanitary sewers, water, gas, electricity, telephone, steam, etc.) must be noted so that streets and open spaces can be located.

The presence, condition, capacity, and necessity of circulation facilities must be recorded and analyzed. If a footpath entering a site handles a significant volume of traffic, provision for its continuance must be made; roads and rails must be considered similarly. The appropriateness of project entrances

and exits must be analyzed in terms of environmental and social relatedness.

g. Sensuous Qualities. The sensuous qualities of the site must be inventoried and described in terms of the character of views, focal points, and the character and rhythm of visual sequences. The variety needed to insure an interesting and attractive family housing site can best be provided by a series of various architectural or natural spaces. Therefore, the topographical character of the site should be inventoried for interesting spatial sequences.

The intensity and length of light patterns should be inventoried to ascertain whether there are any constraints on the placement of houses within the area. Efforts should be made to insure that light from adjacent areas does not intrude into the project space.

Data on odors and sound quality, including location, intensity, and possible impact on the location of housing units within the family housing areas, should also be noted.

## 4 SITE REQUIREMENTS AND DESIGN CRITERIA

### Total Site Requirements for Family Housing

#### *Climate*

In site planning, care should be taken to insure that no land uses or residential functions are combined with topographical climatic conditions that prevent a functional, economically maintained development. Site design should use temperature, sun, light, and wind to optimize comfort in residences while minimizing dependency on artificial controls.

Proper solar orientation permits use of natural solar radiation in cold climates and minimization of heat gain in hot climates. In northern latitudes, a southern orientation receives about twice as much solar radiation in winter as in summer. Eastern and western orientations receive approximately two and one-half times as much solar radiation in winter as in summer. In southern latitudes, a southern orientation receives four times as much solar radiation in winter as in summer, and a western orientation receives two or three times the solar radiation of a southern orientation.<sup>5</sup>

<sup>5</sup>C. G. Ramsey, *Architecture Graphic Standards* (John Wiley and Sons, Inc., 1970), pp 78-79.



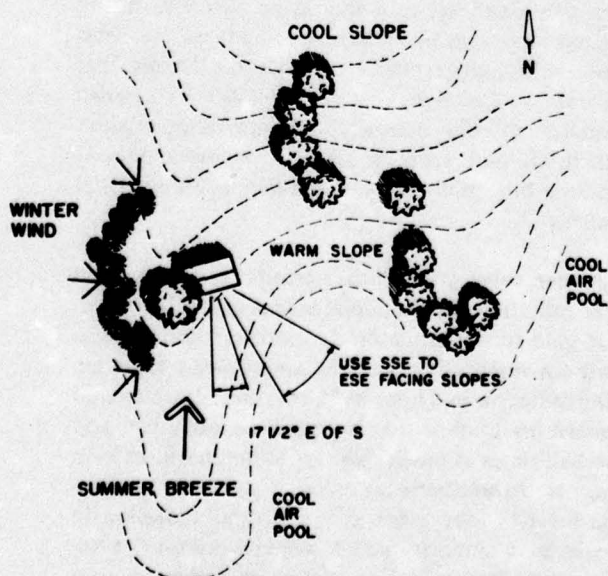
Although more definitive orientation considerations should be investigated on a local basis, the optimum orientation in all regions is generally to the south. A southeast orientation results in greatly unbalanced heat impacts. Further solar control can be achieved through planting; deciduous trees screen solar radiation in the summer and admit it in the winter.

Solar orientation must, however, be correlated with wind impacts. Excessive winter heat loss can be avoided by minimizing building surface and preventing exposure to prevailing winds through proper orientation and planting. Natural cooling in warmer climates can be achieved by admitting summer breezes into the building. Seasonal wind behavior must be determined on a site-to-site basis. Figures 3 through 6 illustrate how thermal orientation and wind can be combined in the four climate categories—cool, temperate, hot and arid, and hot and humid.

In areas with substantial snowfall, plowed snow and snow removal equipment must be accommodated to insure optimum efficiency of operation without interfering with normal residential activities.

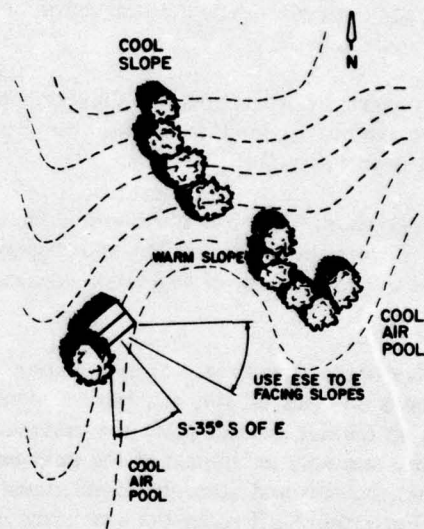
### Topography

Gently rolling land provides greater design opportunities than does a flat site and is also preferable to

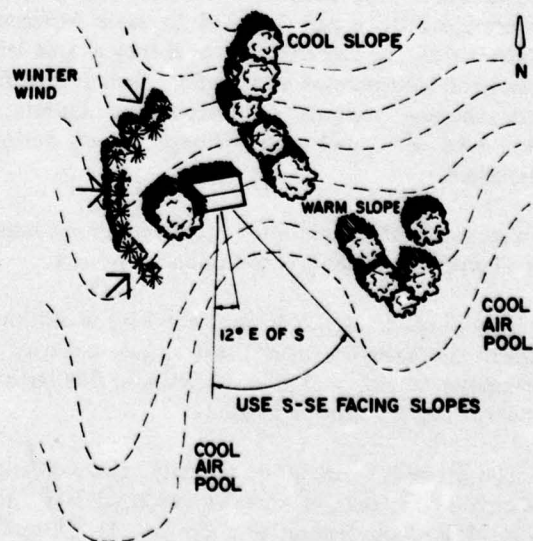


**Figure 3.** Temperate climate. Reprinted with permission of John Wiley and Sons, Inc. from H. Rubenstein, *A Guide to Site and Environmental Planning* (1969).

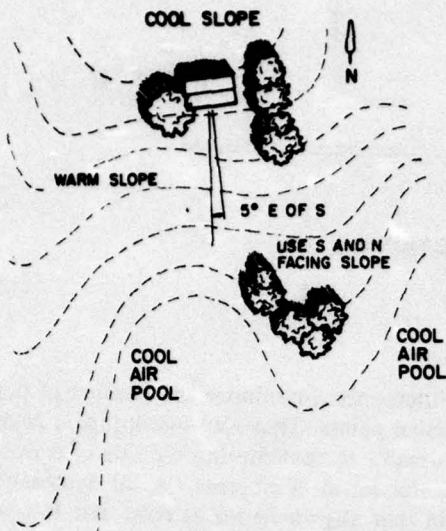
rugged terrain. A grade of at least 1 percent is required for drainage while the maximum slope convenient to build on is about 8 percent. Therefore, ground with a natural slope of 1 to 8 percent will be the most convenient to build on, although this may not always be possible. The long dimension of buildings should parallel natural contours to minimize cutting and filling. The greater view potential of a high site should be maximized.



**Figure 4.** Hot, arid climate. Reprinted with permission of John Wiley and Sons, Inc. from H. Rubenstein, *A Guide to Site and Environmental Planning* (1969).



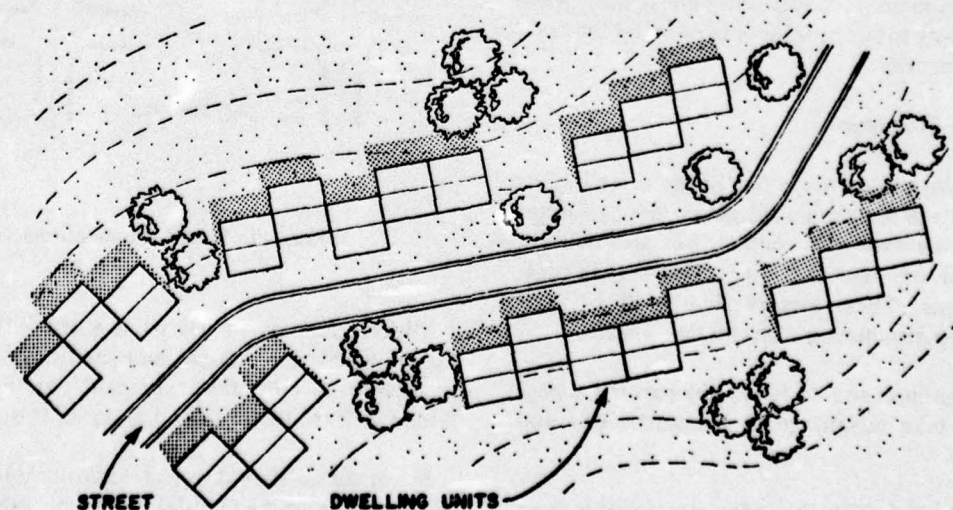
**Figure 5.** Cool climate. Reprinted with permission of John Wiley and Sons, Inc. from H. Rubenstein, *A Guide to Site and Environmental Planning* (1969).



**Figure 6.** Hot, humid climate. Reprinted with permission of John Wiley and Sons, Inc. from H. Rubenstein, *A Guide to Site and Environmental Planning* (1969).

Road systems should also be compatible with the natural terrain. Roads running parallel to or diagonally across natural contours will usually be more economical than roads running directly perpendicular to the contours (Figure 7). Parking on slopes can be hazardous and should be avoided. Cuts and fills that require steep banks, retaining walls, and steps should be avoided whenever possible.

Geographic features such as streams, lakes, bluffs, and rock outcrops should be preserved.



**Figure 7.** Contour orientation.

### *Proximity to Activities and Facilities*

Distance considerations between housing units, base activities, and facilities will help determine circulation requirements within the housing site. The location and distances to regularly used facilities should be determined in order to predict probable traffic generation. Such facilities may include movies, bars, shopping centers, sports facilities, schools, or recreational areas. Internal circulation should, therefore, reflect predicted patterns and volumes.

Residents will probably not walk more than approximately  $\frac{3}{4}$  mile (1200 m) to a destination. Packages to be carried will further shorten the convenient walking distance. Facilities located any farther from a resident's house will result in generation of a vehicular trip, probably by automobile or bus. Dwelling units should be located as closely as practical to these essential services.

Shorter distances allow a greater pedestrian orientation, which will necessitate greater protection from automobile traffic. Vehicular circulation requirements may then be minimal. Maximum walking distances are further discussed in the *Automobile, Camper, and Boat Parking* section (p 30).

The implications of time, although similar to distance, are not necessarily dependent on distance. The maximum convenient walking time is about 15 min. Any trip requiring more time, regardless of distance, will probably be made by vehicle—probably automobile, since waiting time for a bus will normally be perceived as part of the total travel time.





Figure 8. T intersections.

Short automobile trips (within approximately  $\frac{1}{4}$  mile or 1200 m) can be discouraged by minimizing speed, thereby increasing travel time. Longer pedestrian trips can be encouraged by minimizing inconvenience and travel time.

In general, traffic generation will probably be vehicular unless the most frequented facilities are very close to all parts of the housing site. Design considerations for the streets are dealt with in greater detail in the section on Automobile Circulation.

#### Total Site Access

The location of family housing site access points will be supplied to the AE.

An impression of over-control at these access points, either by personnel or entrance design, may present a "fortress" rather than "residential neighborhood" image to the residents and neighboring community. Entrances should open on vistas promoting a community identity. An unobstructed view from a highway to site entrances is essential for both safety and identity.

#### Automobile Circulation

Automobile circulation is one of the most important elements in site design. Street system design involves not only road construction, but also housing arrangement, open space, utility systems, and pedestrian patterns. These factors should all be considered when structuring a circulation system.

Road alignment should follow the existing topography and take advantage of pleasant views and approaches.

Intersections should allow adequate visibility from all directions and provide the fewest possible potential collision points.

"T" intersections minimize the number of potential collision points. They also discourage unwanted through-traffic by interrupting the line of travel. Ts should intersect at 90 degrees ( $\pm 30$  degrees) and maintain that alignment for at least 100 ft (30 m) from that intersection. They should be no closer to each other than 125 ft (38 m) (Figure 8).

Intersection of more than two streets at one point should be avoided if possible because such intersections increase the number of potential collision points and weaken the drivers' recognition of the hierarchy of the road system. "Y" intersections, which are confusing and dangerous, should also be avoided.

Two streets should not cross within 200 ft (60 m) of another intersection (Figure 9).

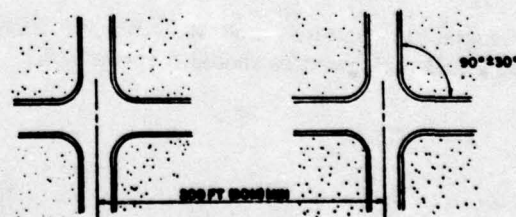


Figure 9. Street intersections.

Street gradients should be less than 10 degrees except where exceptional site conditions exist. A gradient of no more than 5 percent should be maintained at least 100 ft (30 m) from an intersection.

Street widths should reflect vehicular demand and the hierarchy of the circulation system. Since excessively wide streets encourage high speeds and detract from the residential image, they should be avoided.

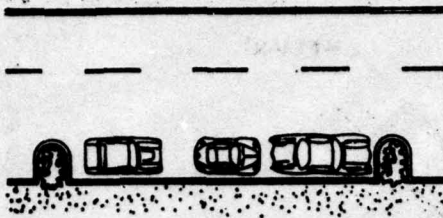


Figure 10. Parking lanes.

The overall hierarchy of a typical highway system contains five basic classes of roads—expressway, major highway and arterial carrying large volumes of traffic at over 30 mph, major interneighborhood collector, local collector, and local residential. The housing site should contain local collector and local residential streets, although major interneighborhood collector streets can be included if the size of the site demands such traffic movement.

Within the housing site, local collector streets should be 24 ft (7 m) wide and residential streets should be 28 ft (8 m) wide, both with a turning radius of 20 ft (6 m). On-street parking should be avoided if at all possible. However, where on-street parking is unavoidable, 8 ft (2.5 m) should be added to collector street widths for each side of parking. No additional width is required for parking on one side of a residential street, but 8 ft (2.5 m) should be added to the width for parking on both sides.

To discourage high-speed traffic on these wider streets, curbing or landscaping may differentiate driving lanes from parking lanes (Figure 10). Traffic lanes must, however, maintain the minimum street widths.

The hierarchy of circulation can be achieved through different street patterns and arrangements including cul-de-sacs, loop streets, "P" loops, curvilinear streets, and the traditional grid pattern.

Cul-de-sacs discourage through-traffic by providing access only to residents on the street. In addition to being quieter, safer for children, and, if properly designed, more picturesque than a grid system, a cul-de-sac arrangement can usually save a substantial amount of paving. Using cul-de-sacs also provides more area in the interior of a block for common open space.

Cul-de-sacs should be positioned so they do not appear to be through-streets or to terminate collector streets.

Although the round turnaround is the most commonly used configuration for the closed end of the cul-de-sac, rectangular ends with parking spaces or "Y" turnheads can give satisfactory results.

The paved area of a round turnaround must be wide enough to allow truck delivery, snow removal, and emergency equipment. The standard diameter of the paved circle is 90 ft (28 m) with a 100-ft (30 m) diameter right-of-way. A center circle of no more than 26 ft (8 m) diameter can be landscaped to provide visual relief, as long as emergency vehicles can cross it if necessary (Figure 11). The minimum paved width of a "Y" turnhead should be 60 ft (18 m). Cul-de-sacs should be no longer than 500 ft (150 m) (Figure 12).

Loop streets (Figure 13) provide convenient access, are safe and quiet, allow easy utility engineering, and discourage through-traffic by routing it back to the collector street. Loop streets can distribute traffic further from collector streets than cul-de-sacs, thus avoiding the turnaround problem. One-way traffic control can also allow narrower paving widths, thus reducing cost, slowing traffic, and providing a safer environment. The interiors of the large blocks formed by the collector network can be used as common open space.

A loop street should have no more than 65 dwelling units feeding onto it, yet should not be so short as to create small islands with a few dwelling units surrounded by streets.

"P" loops (Figure 14) are similar to loop streets but contain only one access. The interior of the "P" loop can be used for dwelling units and yards, while the interior of the "superblock" formed by the collector streets provides common open space. Since a "P" loop occupies considerably more area than a cul-de-sac, it may penetrate deeper into the "superblock," thus reducing the available open space. Larger "superblocks" can be formed by widening the spacing between collector streets; however, this may cause inconvenient circulation.



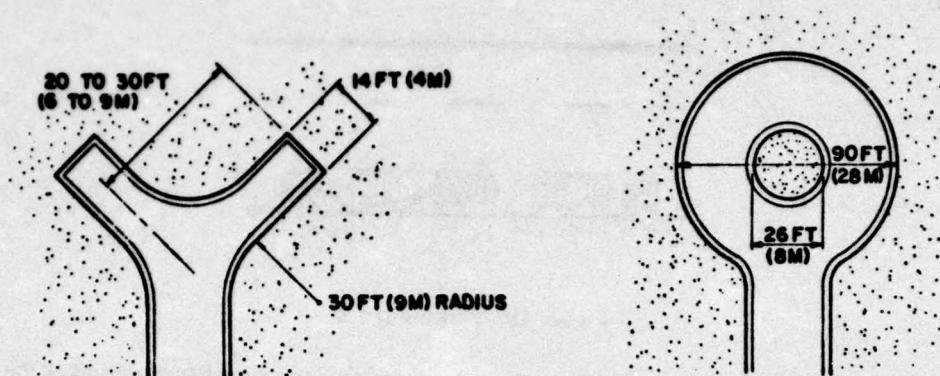


Figure 11. Cul-de-sac ends.

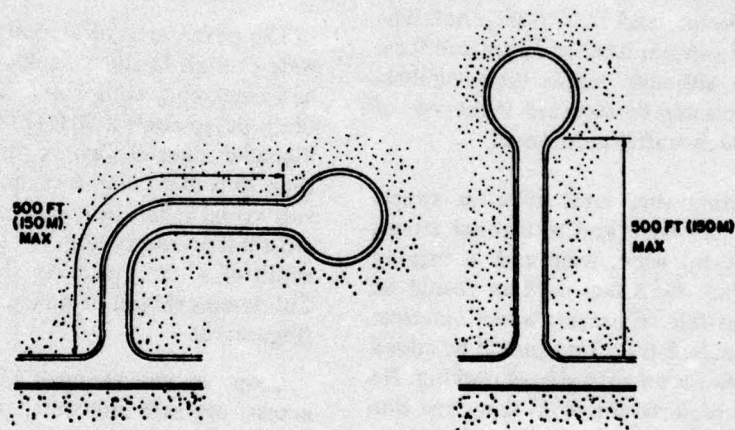


Figure 12. Cul-de-sac lengths.

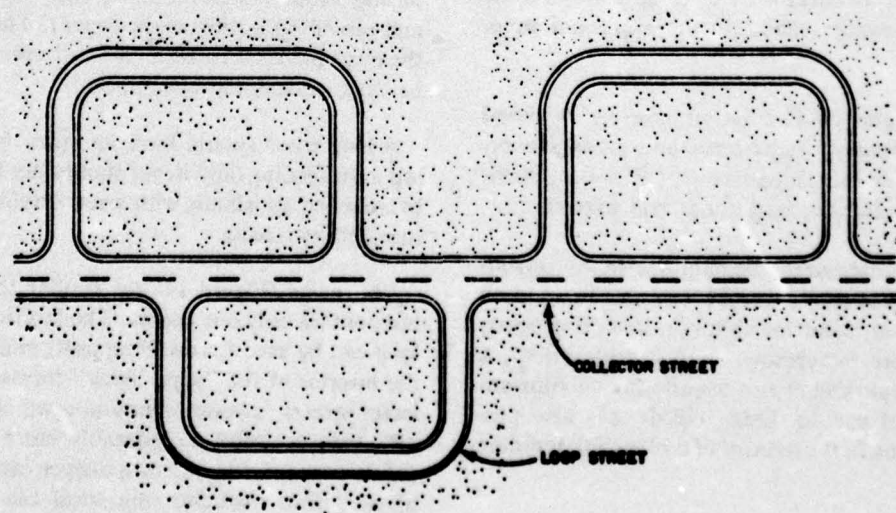


Figure 13. Loop streets.

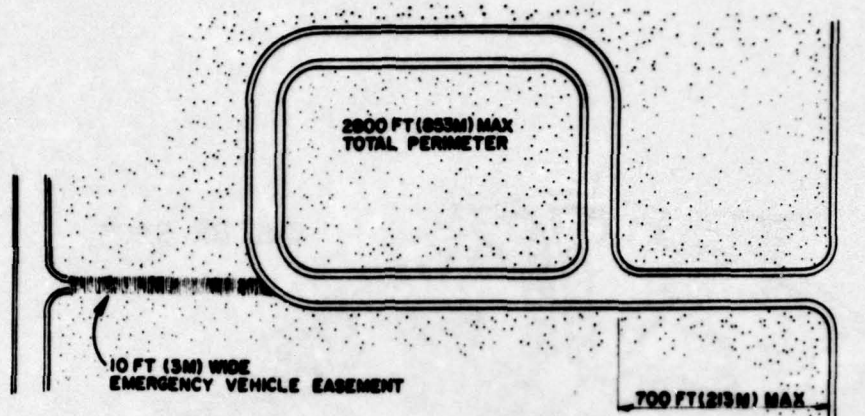


Figure 14. P-loop streets.

The entrance leg of a "P" loop should not be longer than 700 ft (213 m). The total circumference of a "P" loop should not be greater than 2800 ft (853 m). A permanent emergency vehicle easement to an adjacent street should be provided at the end opposite the entrance. If a "P" loop services more than approximately 100 units, further consideration should be given to the number and width of street lanes.

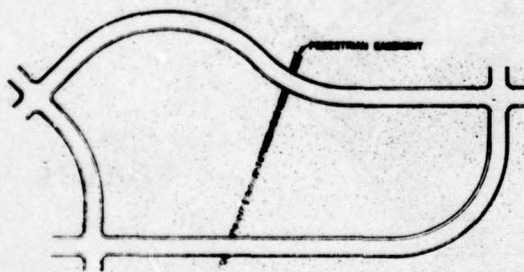


Figure 15. Curvilinear streets.

Curvilinear streets (Figure 15) take advantage of the existing site topography and follow natural contours better than other street systems. Varying views and changing vistas slow traffic and provide variety and interest. Block interiors, however, may be smaller, thus reducing the amount of potential common open space. Rather than a few large open areas, the overall open space system contains more smaller open areas. Street crossings must be provided to connect these open spaces.

Figure 16 illustrates several street types used in a typical "superblock" arrangement.

Although the grid is easy to follow and recognize in terms of organization and street hierarchy, its rectangular pattern and regularity often lead to monotony and lack of character. These shortcomings are emphasized by uniformity of setbacks, building type and spacing, unimaginative landscape design, and lack of attractive views and vistas. However, these faults are not necessarily inherent in the street pattern itself, as all street patterns are equally susceptible to such design shortcomings. The basis of the grid system is the regularity of interconnections. Grid blocks need not be geometrically regular or be equal in size and shape. Grid streets, likewise, need not be long, straight, or unbroken.

Block sizes should be maximized to reduce the number of streets and, therefore, paving and curbing expenses. The interiors of large blocks can be used as open space by the residents. For pedestrian convenience, however, continuous frontage of a block should not exceed 1200 ft (365 m). This frontage may be extended to approximately 1600 ft (487 m) if a pedestrian access through the interior of the block is provided (Figure 17).

The length, frontage width, and size values mentioned above have been established to provide efficient operation of residential, service, and emergency vehicles. However, these values should not unduly restrict the site planner's creativity. Dimensions contrary to these standards may be used if they satisfy all essential vehicles' operational requirements and impose no adverse impacts on the residential environment.

#### *Pedestrian and Bicycle Circulation*

Walkway plans should follow the anticipated natural pattern of pedestrian traffic, as pedestrians usually take the shortest possible path to their



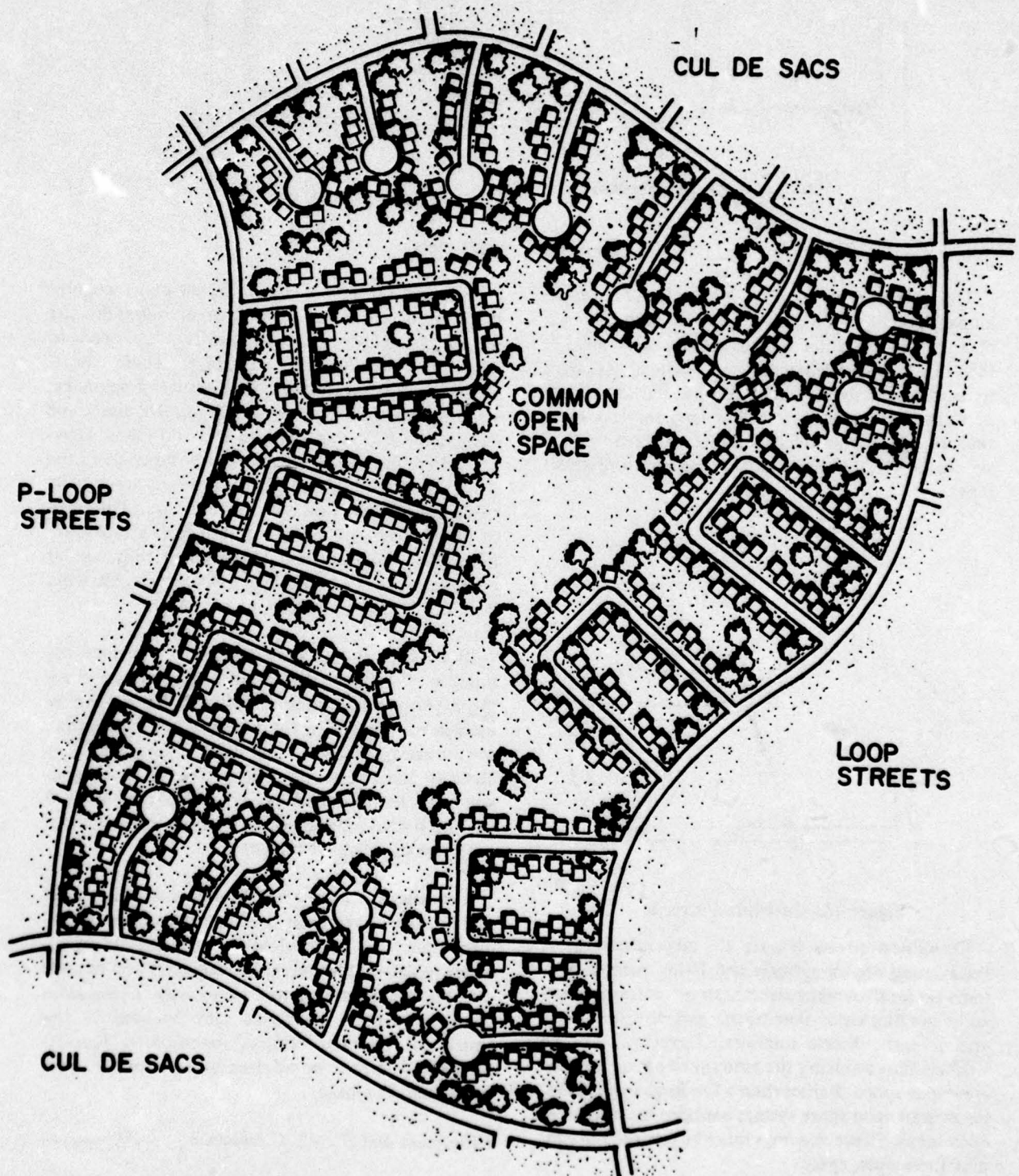


Figure 16. Superblock concept.

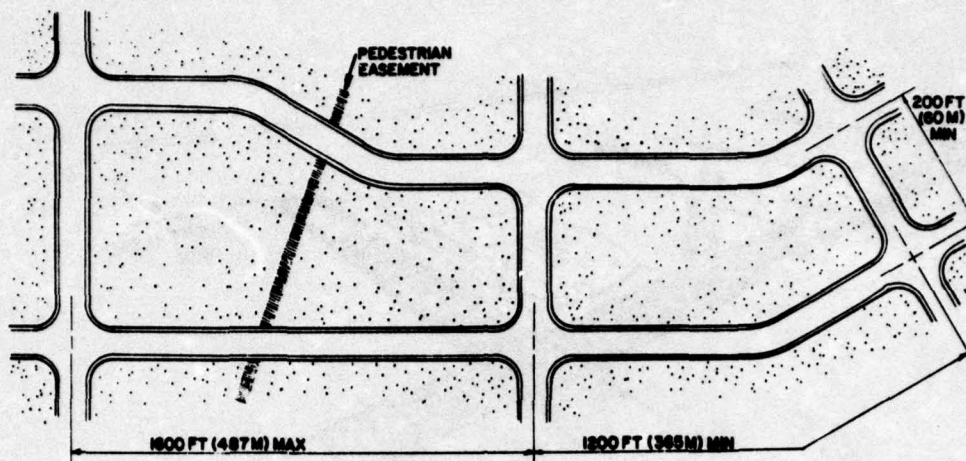


Figure 17. Grid block size.

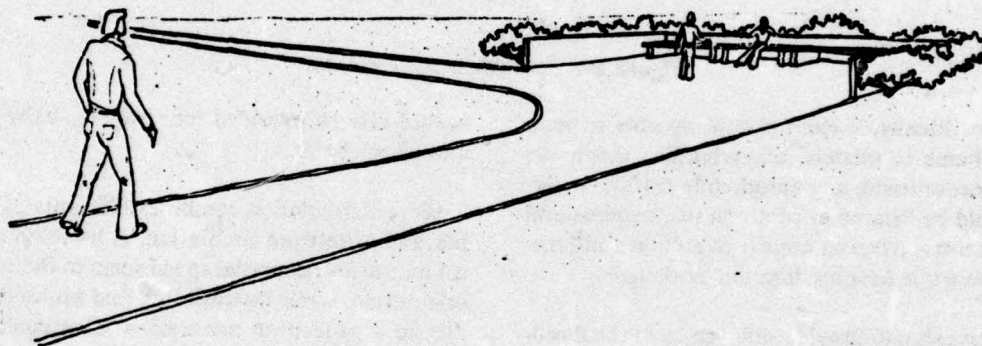


Figure 18. Pedestrian paths.

destination. The walkway network may be independent, superimposed over the vehicular circulation network, or coincident with the more heavily travelled streets, such as major collectors or arterials.

Pedestrian paths should be attractive and interesting, and follow a sequence of spatial or activity events so the pedestrian is always aware of an observable destination (Figure 18).

Separation of pedestrian and vehicular traffic must be obvious and distinct. Intersections are potentially dangerous and should be clearly recognizable from both the road and the walkway (Figure 19). The pedestrian should have priority over the automobile at these intersections.

Paths should have a wide enough buffer or right-of-way to give them sufficient identity within an open space, among dwelling units, or along roadways.

Sidewalks at least 4 ft (1.2 m) wide should be provided on both sides of all residential streets. Paths

through open spaces should be at least 5 ft (1.5 m) wide. Walkways adjacent to parking areas should be at least 6 ft (1.8 m) wide (Figure 20).

Pedestrian paths are especially important to children, who require the most protection from automo-

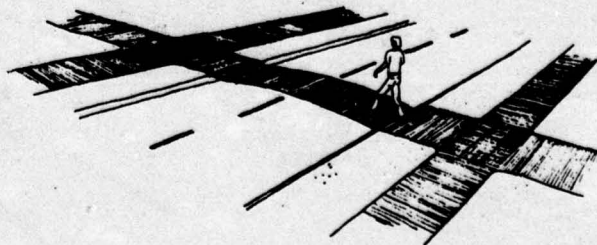


Figure 19. Street crossings.



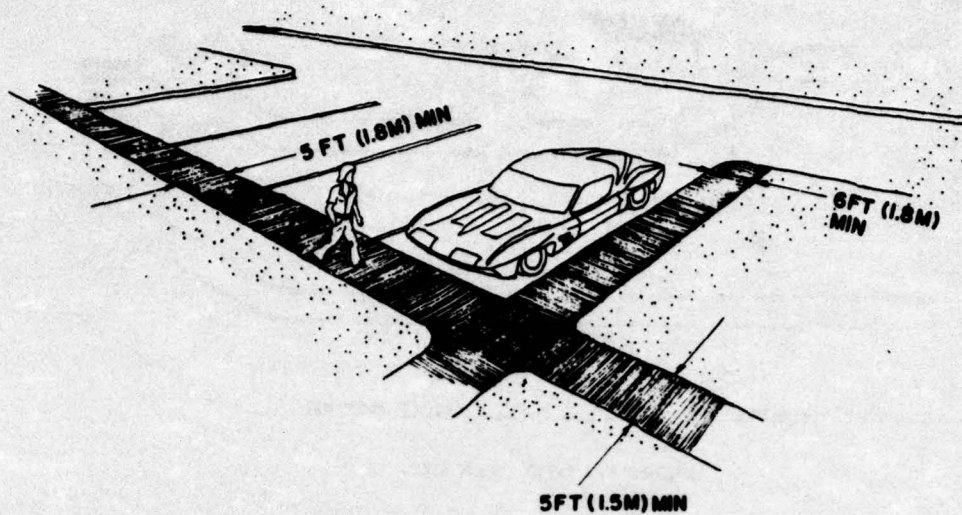


Figure 20. Pedestrian path widths.

bile traffic. Ideally, a child should be able to walk from his home to schools, playgrounds, and parks without encountering any automobile traffic. Walkways should be located in common open spaces and should be attractive and appeal to a child's inquisitive nature while keeping him out of danger.

Walkways should provide safe access to the dwelling unit from streets, driveways, and parking areas. The alignment and grade should not allow large volumes of runoff water to cross the path. Pedestrian paths should follow the site's natural contours but should not have a grade steeper than 10 percent. Where steps are necessary, a minimum of three risers is required. Single risers are dangerous and should be avoided. Where steps are required, ramps

should also be provided for strollers, baby buggies, and wheelchairs.

Bicycle circulation combines elements of automobile and pedestrian circulation. A bicycle's mechanical nature and potential speed seem to dictate a road orientation, while its flexibility and mobility seem to dictate a pedestrian orientation. Consequently, the bicycle should be accommodated within both the vehicular and pedestrian circulation networks.

Bicycles can share minor residential streets with automobiles if traffic volumes are at a safe level. However, a protected bicycle path should be provided with site collectors and arterial roads (Figure 21).

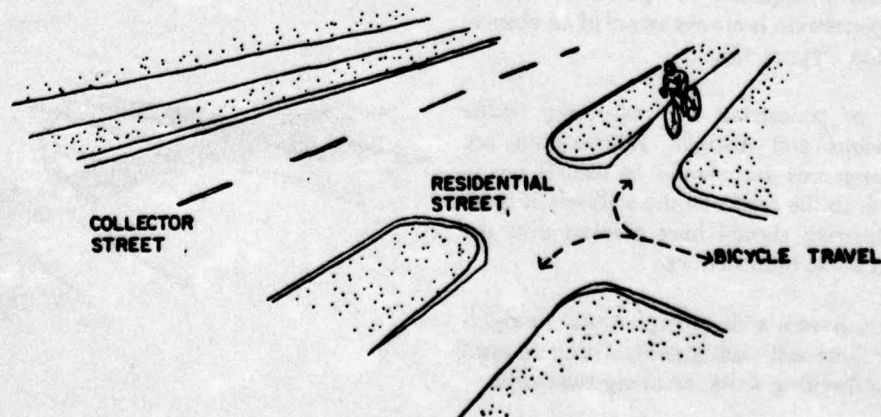


Figure 21. Bicycle paths.

Bicycle paths should roughly parallel pedestrian paths, without presenting a hazard to pedestrians. The paths should not create a barrier or obstacle to the activities in adjacent open spaces. Designated bicycle parking lots should be located adjacent to facilities, thus preventing interference with either automobile or pedestrian activities.

#### *Growth and Expansion*

Future growth within the total family housing area must be considered when developing site concept plans for a particular phase or segment of the total area.

#### *Land-Use Intensity/Housing Type*

The greatest impact land-use intensity (LUI) has on site planning is the allocation of open space in relation to the amount of built area. Allowable land-use intensities range from 3.0 for colonels to 5.5 for enlisted men.\*

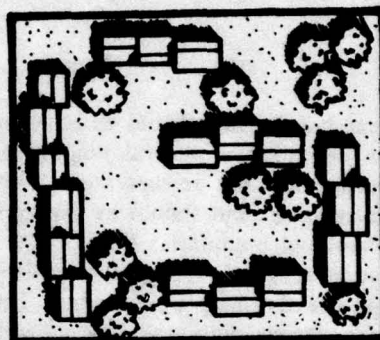
Open space ratio (OSR) is the proportion of open space relative to total floor area of a building. For an LUI of 3.0 the OSR is 6.4,\* indicating that the open space allotted to each dwelling unit must be approximately 6½ times the floor area of that unit. For an LUI of 4.5, the OSR is 2.7, indicating that approximately 2¾ times the unit's floor area must be allotted to open space. Low intensities demand a greater proportion of open space than high intensities.

Floor area ratio (FAR), the proportion of total floor area to available land area, is similar to OSR in its indication of required open space. For an LUI of 3.0, the FAR is .1, indicating that only one-tenth of the available land may be allotted to floor area. For an LUI of 4.5, the FAR is .3, indicating that three-tenths of the available land may be allotted for floor area.

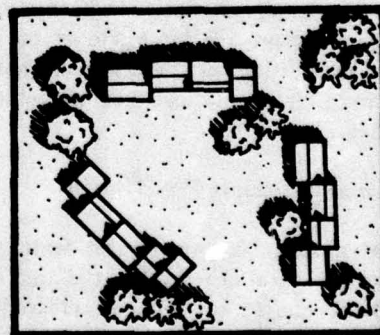
Housing type also affects the allocation of open space per building. Low-density buildings such as detached houses and duplexes of one or two stories require less actual open space per building area because there is less total floor area per building coverage. Higher density buildings require more actual

open space per building area because of their greater total floor area per building coverage.

Given a fixed FAR, OSR, LUI, and required number of dwelling units, actual open space differs greatly with different housing arrangements. For example, assume a requirement for 18 dwelling units with an FAR of about .22, OSR of about 3.7, and LUI of about 4.1. Actual open space for a single-story townhouse will be about 3¼ times the building coverage; actual open space for a two-story townhouse will be about 6¼ times the building coverage (Figure 22).



a. 18 one-story townhouse units: open space = 3¼ X building coverage



b. 18 two-story townhouse units open space = 8 X building coverage

Figure 22. Building coverage.

#### *Neighborhood Concept*

Residential needs that must be fulfilled include a sense of place, personality, recognition, familiarity of neighbors, social organization, and escape from the anonymity of an overly large body of residences.

Preferred neighborhood size is 50 to 100 families—the optimum number for achieving familiarity and

\*Design Folio for Family Housing (Department of Defense, May 1969).

\*The appendix presents applicable land-use intensity standards.



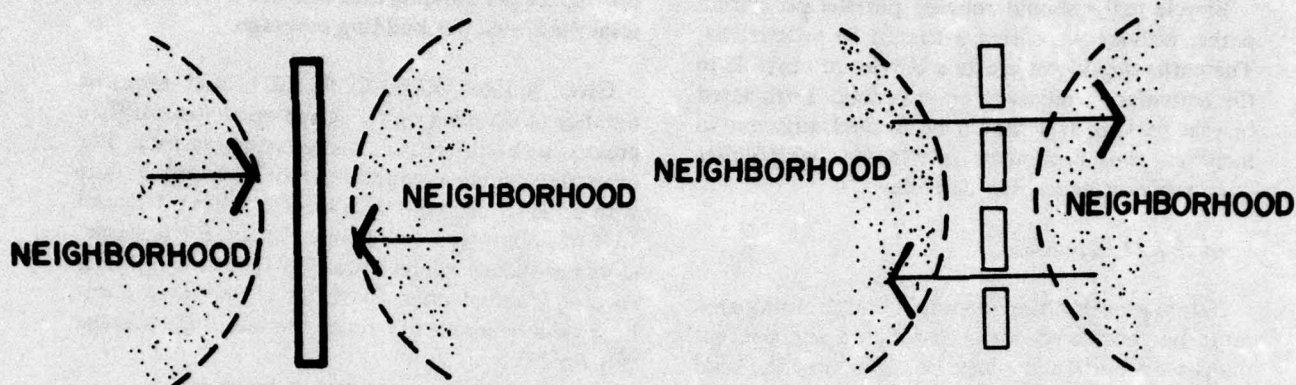


Figure 23. Neighborhood definition.

identity.<sup>7</sup> Each housing site should be large enough to allow the definition of several neighborhoods. Neighborhoods should not be separated or isolated within the housing site but should be distinctly defined, by edges, not boundaries (Figure 23). Such definition can be achieved through the architectural treatment of the dwelling units, edges between neighborhoods, landscaping, and identity with different natural site features, either natural or man-made landmarks, or neighborhood common areas.

Although the total installation housing scheme may place housing on one large site or on a few smaller sites, no housing site should be so small that its families feel isolated and lose a comfortable residential feeling.

#### *Conservation and Amenity Preservation*

A natural amenity is any natural feature that exemplifies the natural character of the area and is an asset to the quality of the built environment. Examples are tree stands, rock outcroppings, hills or valleys, rivers, streams, views, vistas, and wildlife homes. Man-made amenities include historic structures or landmarks.

These features should be preserved to the greatest extent possible during design and construction. Their presence will give the residential environment interest, character, and stability, a particularly important factor in eliminating military personnel's feelings of transiency. Decisions about preservation and priorities are largely subjective and must be

<sup>7</sup>R. C. Knight, R. D. Neathammer, J. L. Pfeister, and R. M. Dinnat, *Attitudes and Preferences of Occupants of Military Family Housing Communities*, Technical Report D-22/AD77769 (CERL, April 1974), pp 12 and 25.

based on local conditions, values, and installation mission.

The landscaping goal of preserving existing vegetation requires precaution against damage to vegetation during planning, design, and construction. Specifically, this requires that:

- a. The soil level around the base of a tree should not be changed.
- b. The water level around a tree or vegetation should not be substantially altered.
- c. Tree rooting areas should be protected during construction; no more than 25 percent of the root area should ever be covered or removed.
- d. No liquid wastes should be disposed of near a tree's root area.
- e. No fires should be lit under a tree.
- f. Fencing and walls must not approach the roots of the tree.

#### *Recreation/Open Space*

Recreational open spaces providing areas for both active uses and passive uses should be integrated into a smoothly flowing network of outdoor living spaces. Recreational areas should accommodate the needs of all age groups in the housing site. Open space areas for each age or activity requirement affect the open space network and the housing site as a whole.

Outdoor recreation space for 2- to 6-yr olds should be free from vehicular hazards and accessible with-

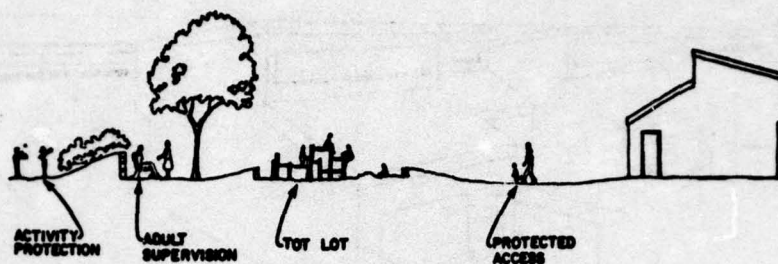


Figure 24. Tot lots.

out crossing a street. These play areas should be protected from the play areas of older children. Shade or shelter and a place for parental supervision should be provided. These play areas should be observable from the dwelling units, preferably from the kitchen, and should be connected to the units by a walkway system. The size of the play area should be approximately 50 sq ft (5 m<sup>2</sup>) per child, with a minimum lot size of about 2500 sq ft (250 m<sup>2</sup>) serving 50 children. Play areas should be within 300 to 400 ft (90 to 120 m) from the dwelling units they serve (Figure 24).

Outdoor recreation for children between 6 and 14 should also be free from vehicular hazard. Because of noise, play areas should not be located directly adjacent to housing units.

Children's play areas should include enough space for game fields, ball fields, and similar outdoor activities. These facilities, however, should not be developed in this area as they will be found elsewhere on the installation. Complex and challenging equipment should be provided in playgrounds. Such equipment should include climbers, swings, slides, whirls, and basketball backstops. The land should be reasonably level and located for easy access by children.

Open, undeveloped space may also be used for casual and passive outdoor activities such as strolling and socializing. Such space may be distributed throughout the housing site. There is no minimum area of park space that must be located in any one place.

Total space allotments for these recreational areas should be approximately 5 acres for each 100 households.

Unit types and family composition must also be considered when planning recreational proximities.

A four-bedroom unit is likely to accommodate more children than a two-bedroom unit. Therefore, larger units should be arranged closer to open spaces and recreational facilities.

A hierarchy of open spaces (Figure 25) should be established to achieve a favorable relationship between the dwelling unit, activities, and spaces. A "private" outdoor living space or yard immediately adjacent to the dwelling unit should serve only that unit as an extension of the private living spaces inside. A semicommon zone immediately adjacent to the individual yards should serve the immediate cluster, block, or adjacent group of units and should include a tot lot or casual gathering area. Activities generated should not unduly disturb residents in the dwelling units. The common recreational open spaces serving the entire neighborhood or housing community should provide the active recreational facilities, sufficiently buffered from the dwelling units, but not inconveniently distant.

#### Fire Protection

All housing units should be located within 5 miles (8 km) of a fire station. Access from the fire station should be direct with a minimum of obstructions and delays.

Fire hydrants should be spaced to provide the proper rate of flow to the farthest unit within service of the hydrant. System design shall provide a minimum residual pressure of 10 psi (69 kN/m<sup>2</sup>) at each fire hydrant. All parts of all housing units must be within a 350-ft (110 m) hose length of a hydrant. Hydrants may be roughly located at each street intersection and midway in each block.

Hydrants should never be located closer than 25 ft (18 m) to a building except where the chance of a wall collapsing is remote. For traffic and safety reasons, a hydrant should not be closer than 3 ft



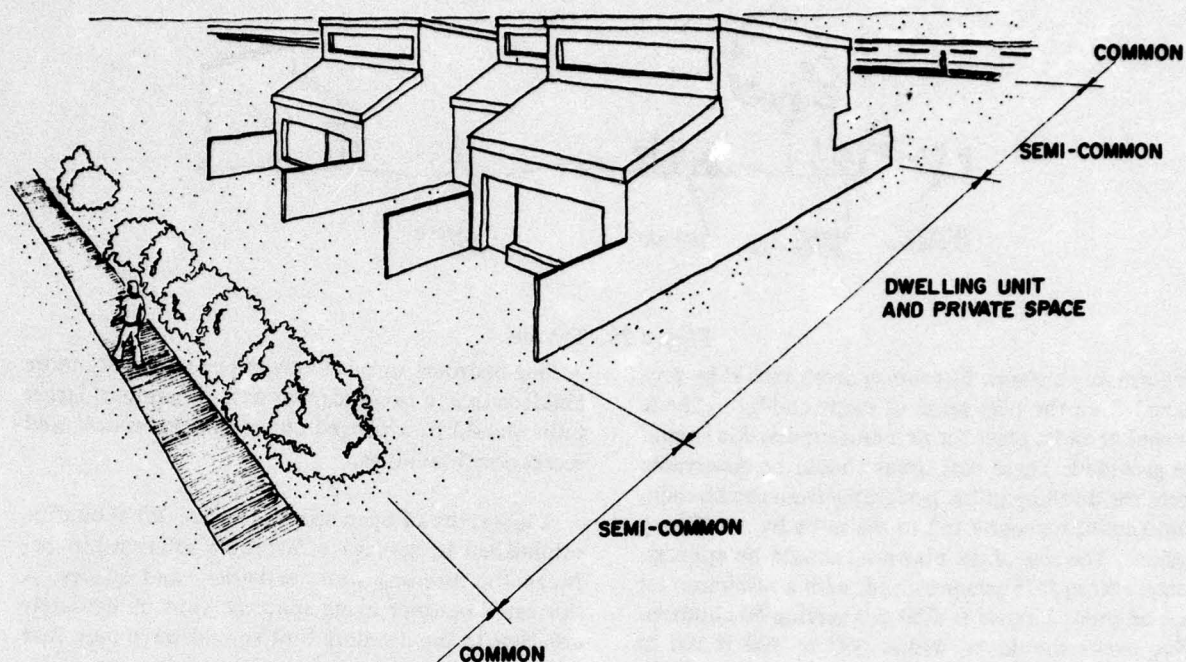


Figure 25. Hierarchy of open spaces.

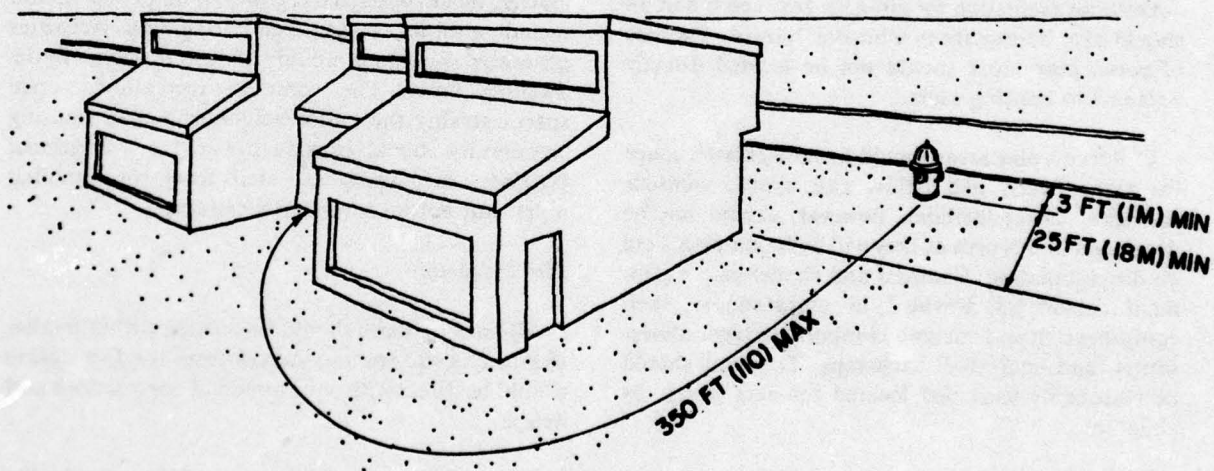


Figure 26. Hydrant location.

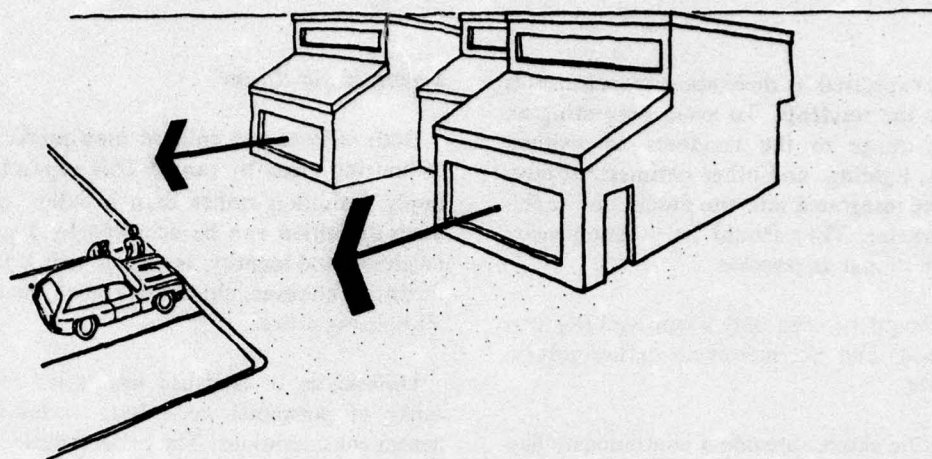
(1 m) to a road's edge (Figure 26). A pumper, however, must be able to locate not more than 7 ft (2 m) from the hydrant; therefore, stabilizing the soil around the hydrant to carry any possible vehicular loads should be considered. A water flow of 500 gpm (7.89 m<sup>3</sup>/min) for single-story buildings and 750 gpm (2.84 m<sup>3</sup>/min) for two-story buildings should be maintained.

Valves should be located so that no more than two

hydrants are taken out of service in the event of a water main breakage.

Overhead utilities such as wires, lights, and poles should be avoided where they may interfere with the operation of emergency equipment.

Spacing between dwelling units depends on the type of building, type of construction, and desired fire resistance rating.



**Figure 27. Public observation.**

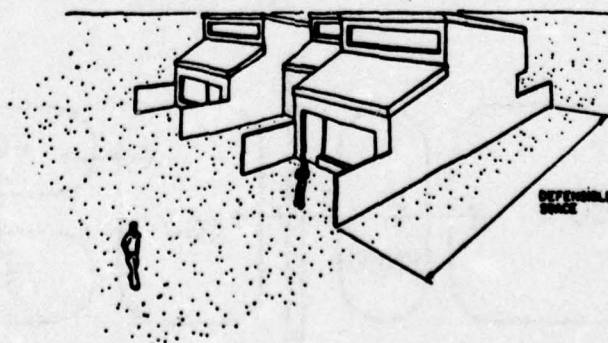
The dwelling unit architect and the site planner must collaborate on this matter in order to determine the most desirable combination of building spacing, possible window sizing constraints, and dwelling unit construction type.

#### ***Security and Site Lighting***

Potential danger areas are parking lots, pedestrian paths, congregating areas, yards, mail box areas, and concealed places. Primary control of undesirable behavior should be through general public surveillance. Parking lots, pedestrian paths, and mail boxes should be directly visible from a number of dwelling units, preferably from rooms that are occupied most of the day and evening (Figure 27). Danger areas should be uniformly illuminated at 1 foot-candle (10.764 lucas). Lights should be placed to avoid direct glare into dwelling units.

Clear yard definition around the dwelling unit provides a "defensible space" and discourages pedestrian intrusion (Figure 28). Units should be arranged so yards are observable from a number of different dwelling units without intruding on privacy. If necessary, yards should be illuminated at night; however, lights should not shine directly into the units. Buildings should be arranged to avoid dark, blind corners. Dead-end streets and excessively long cul-de-sacs should be avoided.

If a security problem is external, the entire housing site must be guarded from intruders. Access to the site should be limited to a few points. The remainder of the site perimeter should be closed to outsiders. Since controlled exit is as important as controlled entry, limited ways of escaping the site also discourage intruders.



**Figure 28. Defensible space.**



The image expressed by these security measures is important to the residents. To avoid presenting an intimidating image to the residents or visitors, fences, walls, lighting, and other perimeter protection should be integrated into site design and architectural character. They should be as unobtrusive and noninstitutional as possible.

Fencing should be used only where security precautions dictate and not merely to define government property.

Road lighting should provide a continuously illuminated pavement surface and illuminate roadside areas so movement, activities, and potential hazards are visible. Road lighting should maintain landscape and architectural compatibility and avoid an institutional image.

All pedestrian paths should be illuminated for convenience and safety, thus making the paths available to pedestrians at night. Fixture design and illumination levels should reflect a human scale as well as maintain landscape and architectural compatibility.

All lighting systems should avoid glare or intrusion into dwelling units. Lighting levels should be at 1 foot-candle (10.764 lucas) for roads and 4 foot-candles (43.056 lucas) for pedestrian paths.

Street lighting fixtures should be located at street intersections and at intervals of not more than 200 ft (60 m).

To avoid over-lighting the site, only activity areas used most frequently should be selected for lighting. These areas may include dwelling unit paths, cluster common areas, tot lots, and the residential service center.

### Separation of Ranks

Both officers and enlisted men prefer separation of housing areas by rank.<sup>8</sup> This separation should imply definition rather than isolation of an area. Such definition can be achieved by a major road, neighborhood identity, or buffer strips. Community facilities, however, should be equally convenient to all housing areas.

Differences in land-use intensities for different ranks of personnel necessitate variations in site design considerations. The main criteria for separation of ranks are that NCOs be located near SNCOs, and SNCOs be located near CGOs (Figure 29). The designer can decide on the rest of the housing arrangement.

### Housing Arrangement Criteria

#### Site Image

The overall image of the family housing site is most important to a sense of place, well-being, and "home." A high quality site image encourages a sense of belonging and pride and discourages a sense of transiency and impermanence. The family housing site should have a normal residential atmosphere and avoid the impression of institutional housing. Objectives for a successful housing image include: quality housing design; an interesting and varied streetscape; identity of individual territory; and substantial landscaping.

<sup>8</sup>R. C. Knight, R. D. Neathammer, J. L. Pfeister, and R. M. Dinnat, *Attitudes and Preferences of Occupants of Military Family Housing Communities*, Technical Report D-22/AD777769 (CERL, April 1974).

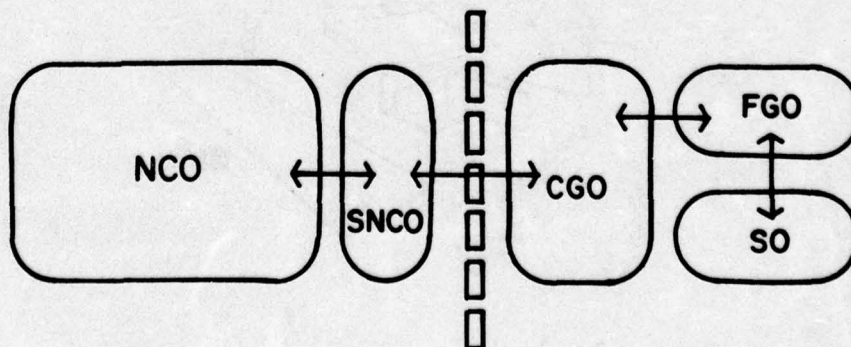


Figure 29. Separation of ranks.

### Site Variety

Site variety may be achieved through a mix of building types and densities. Variety of housing types within the site is a desirable site design feature.<sup>9</sup>

Different open space requirements for different building intensities help provide a diversified image. Varying proximities to activity locations also creates variety in site design. Dwelling units located close to various activities will have a different character from those located in a quiet area of the site.

Since street design influences housing unit arrangements, differing street geometries can also be used to achieve variety.

### Cluster Arrangement

Uniform distribution implies even spacing of the dwelling units along the street; each unit has its own exterior space. Clustering implies closer spacing of a smaller number of units, thus compressing individual open spaces and creating a larger common open space (Figure 30).

Physical separation of the units in a uniform distribution scheme allows greater privacy and more exclusive use of the individually controlled open space. The amount of open space available to each unit, however, is limited. The closer proximity of units in a cluster arrangement may detract from the privacy of each unit, but increases the amount of open space available by reducing individual private spaces. The cluster scheme is generally recognized as being more efficient in terms of land use.

Within the dwelling unit grouping, setbacks and open spaces should be varied to avoid monotony in massing and space relationships. Setbacks and spacing should provide reasonable privacy, minimize adverse effects of traffic, and be consistent with the topography and other site conditions.

Clearance between and adjacent to buildings should consider requirements for fire protection, safety, privacy, and emergency access. The following minimum separations should be maintained:

25 ft (8 m) from the front of house to the curb

20 ft (6 m) from the side of carport or garage to the curb

20 ft (6 m) from the side of house to the curb

16 ft (5 m) between the side of carports or garages attached to house

20 ft (6 m) between side walls of houses

80 ft (25 m) between the rear walls of houses

8 ft (2.5 m) between the street face of carport or garage to the curb when the second off-street parking space is parallel to the carport or garage

28 ft (9 m) between the street face of carport or garage to the curb when the second off-street parking space is tandem to the carport or garage

40 ft (16 m) between side wall and rear wall of houses

40 ft (16 m) between side walls of houses with patios in side yards.

Each dwelling unit should be provided with at least one yard which serves as a private outdoor living area. Within a yard, a privacy zone should be provided to separate indoor from outdoor activities. A privacy zone should also be defined for any side of a dwelling unit that is open to another outdoor activity, whether part of a yard or not.

Yards should be at least 35 ft (11 m) deep with a defined privacy zone of 30 ft (9 m) (Figure 31). Yard depth may be reduced to 25 ft (7 m) and the privacy zone to 18 ft (5 m) if: the privacy zone is enclosed by a 6 ft (2 m) high enclosure (Figure 32), the privacy zone is 6 ft (2 m) above the adjacent activity area (Figure 33), or natural site features provide sufficient privacy. Additional outdoor spaces adjacent to habitable rooms with windows should have a 25-ft (8 m) yard depth and a 12-ft (4 m) privacy zone (Figure 34). No privacy zone is required if these windows are 6 ft (2 m) above the adjacent horizontal level. No privacy zone is required for a kitchen. It is important that the site designer and the dwelling unit architect collaborate on this matter.

For other habitable rooms, the yard depth should be 18 ft (5 m) with a 12-ft (3 m) privacy zone.

<sup>9</sup>R. C. Knight, R. D. Neathammer, J. L. Pfeister, and R. M. Dinnat, *Attitudes and Preferences of Occupants of Military Family Housing Communities*, Technical Report D-22/AD777769 (CERL, April 1974).



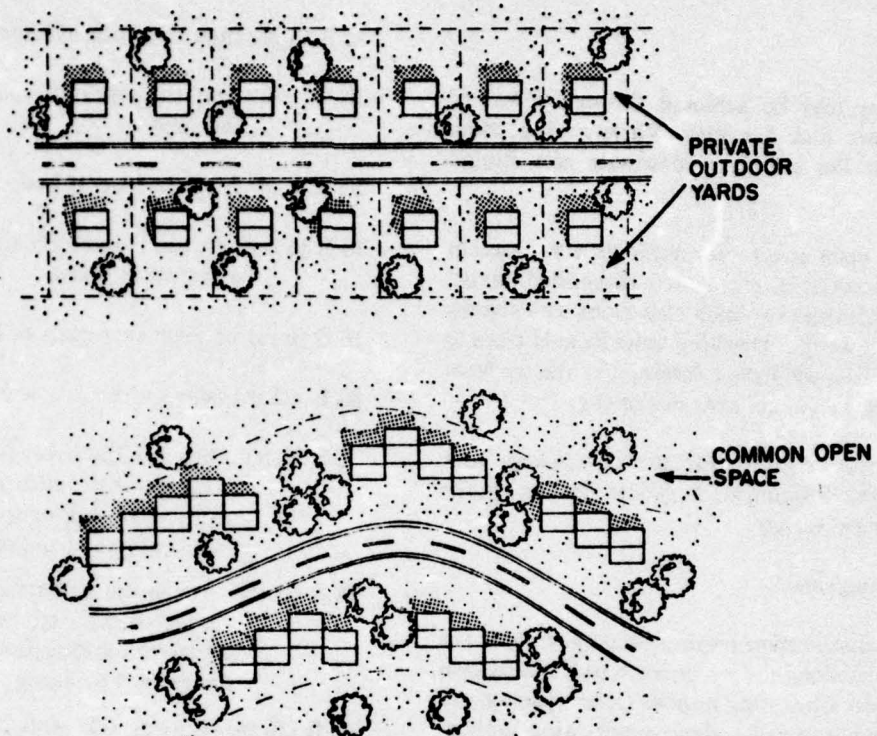


Figure 30. Housing unit arrangement.

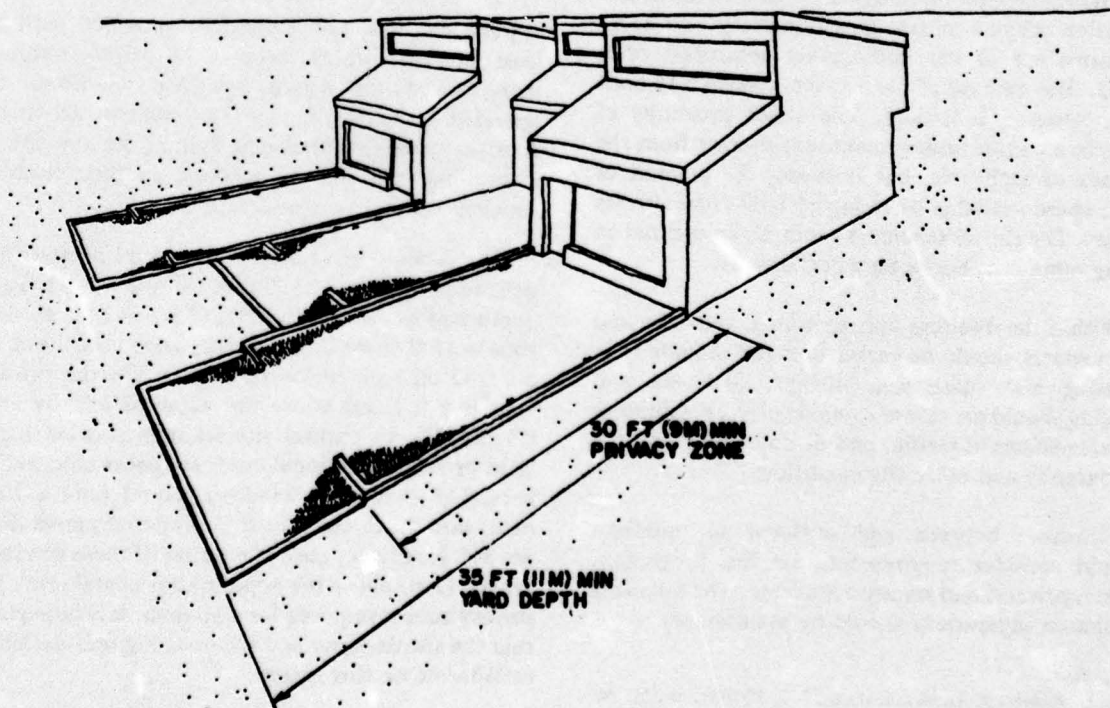


Figure 31. Minimum privacy zone.

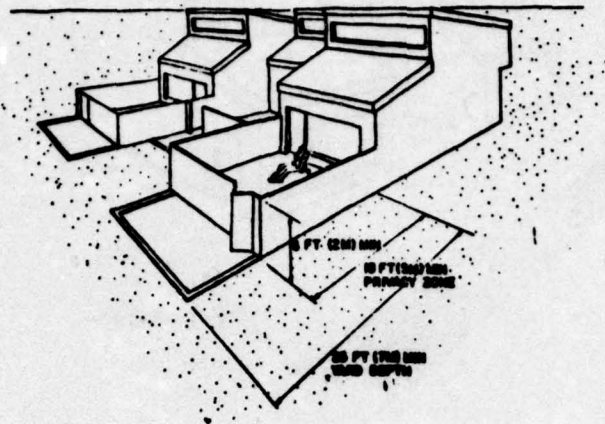


Figure 32. Minimum privacy zone for inclosed yards.

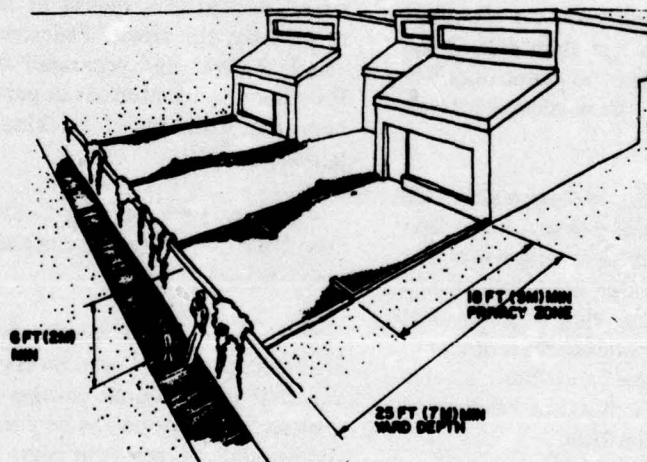


Figure 33. Minimum privacy zone for elevated yards.

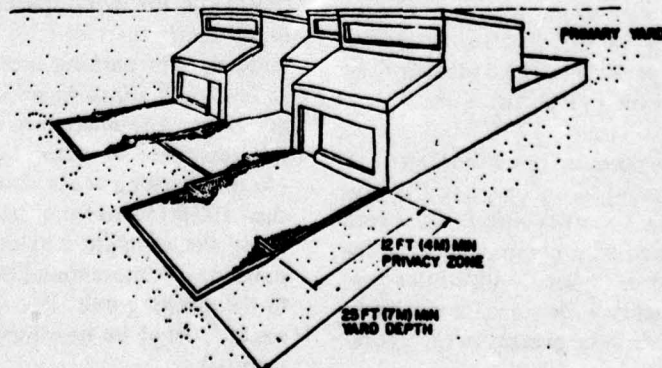
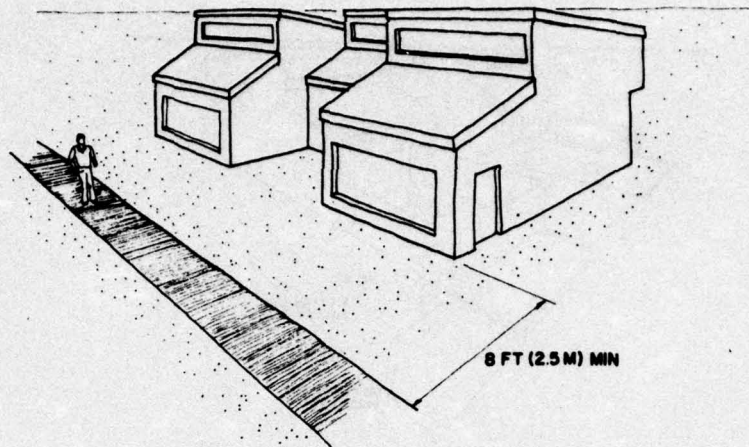


Figure 34. Minimum privacy zone for additional outdoor spaces.





**Figure 35.** Distance of pedestrian path from home.

Walkways should not intrude upon a dwelling unit's privacy. If a window is less than 6 ft (2 m) above grade, the path should pass no closer than 8 ft (2.5 m) from the wall in which the window is located (Figure 35).

Clusters should contain units of compatible size and family composition. Lack of privacy, noise, and activities may cause conflicts between residents of a two-bedroom unit with no children and residents of a five-bedroom unit with eight children. Clusters should, therefore, contain two-bedroom units, two- and three-bedroom units, three- and four-bedroom units, four- and five-bedroom units, or other combinations unlikely to create conflicts.

#### ***Automobile, Camper, and Boat Parking***

Two parking spaces should be provided for each dwelling unit. At least one of these spaces should be sheltered if weather conditions are sufficiently severe. Both spaces should be located off-street, adjacent to the unit. Spaces should be identified as closely as possible with their respective unit.

If common parking is used, no more than seven or eight cars should be grouped in one parking bay without a visual break or other relief. Sheltered parking may be designed as a common facility for each dwelling unit cluster. Figure 36 illustrates possible parking arrangements. Provisions for car washing and maintenance should be present in each parking area.

Parking lots, bays, or shelters should not obstruct the view between the road and the dwelling unit. To provide safe pedestrian movement parallel to the

street, parked cars should be no closer than 20 ft (6 m) from the street. Pedestrian paths should be clearly defined and separated from parking areas. Provisions of turnarounds in parking bays can eliminate the necessity of backing across pedestrian paths.

Planting and screening should not obstruct the vision of drivers either in the parking area or on the street (Figure 37).

Common carports may have spaces allotted for sheltered parking. Common facilities may be better suited than individual garages for accommodating vehicles, since spaces can be pooled to accommodate the changing numbers of cars.

Automobiles should park close enough to the dwellings to provide convenient access and observation. They should not, however, be close enough to intrude on the living spaces. Group parking should be no closer than 25 ft (8 m) from any residential building. The parking area should be no more than 100 to 150 ft (30 to 45 m) from one- and two-family dwellings. The maximum distance from a building housing three or more families should be 250 ft (76 m). Parking areas should not be located more than 100 ft (30 m) from the street, with 200 ft (61 m) being the absolute maximum. Visitors should not have to walk more than 300 ft (90 m) from their car to the dwelling unit. Parked cars, either on- or off-street, should be no closer than 12 ft (4 m) to any sidewalk.

A degree of identity should be maintained between the dwelling unit and its parking place. Although an individual driveway per unit relationship is desira-

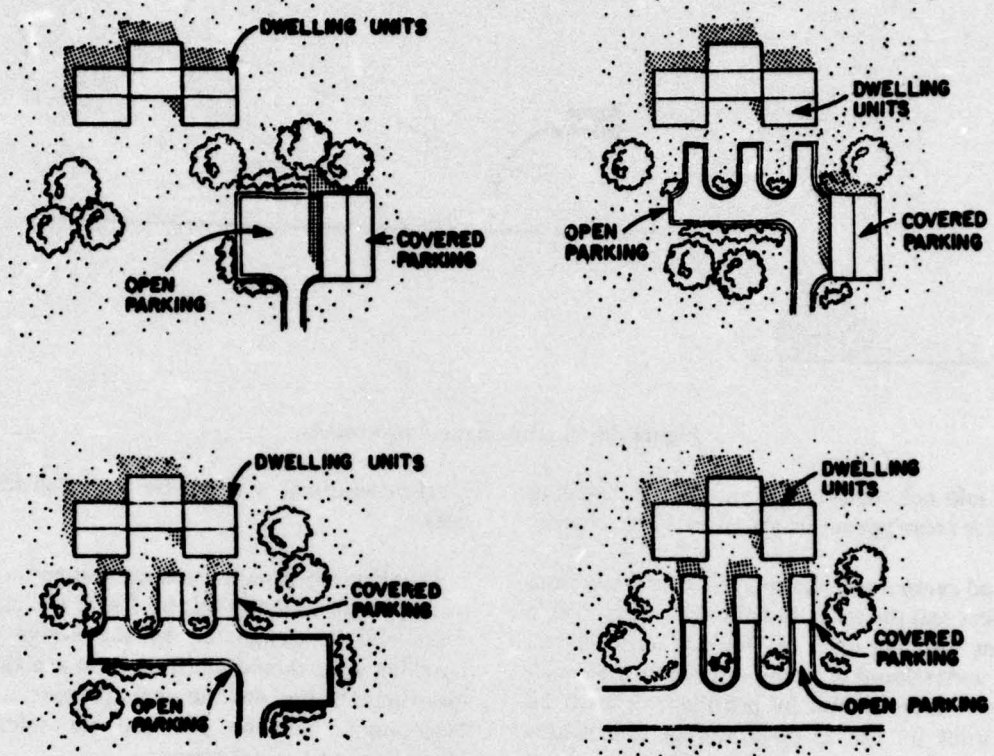


Figure 36. Possible parking arrangements.

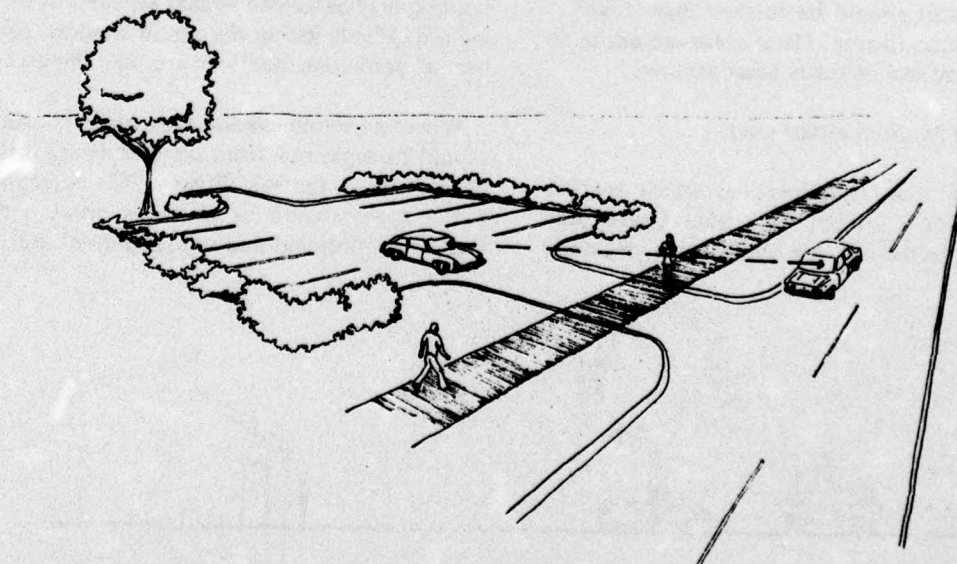


Figure 37. Driver's vision.



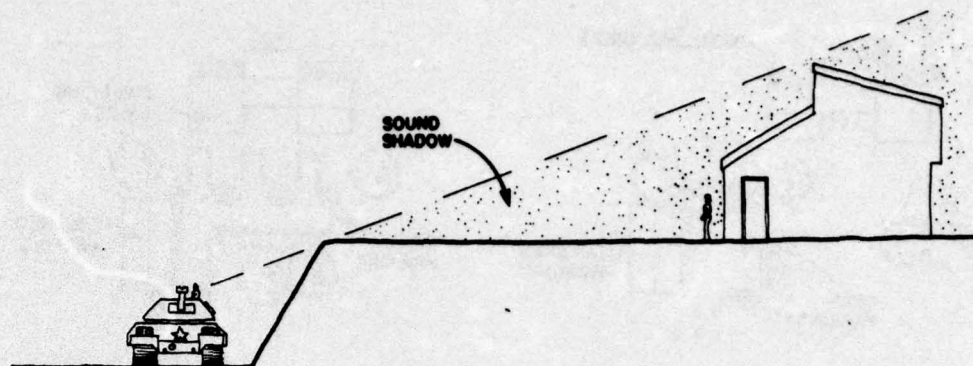


Figure 38. Sound shadow protection.

ble, it should not compromise an efficient dwelling unit cluster arrangement or group parking scheme.

Boat and camper parking should be screened from open spaces and the road, but should be observable from some dwelling units to facilitate surveillance. An open undeveloped area suitable for future development by others should be provided for each 50 housing units for use as open storage. Each area shall be approximately 6,400 sq ft (1920 m<sup>2</sup>) in size. The project's housing and street layout should allow for future development by others of access roads to these open storage areas. These areas shall be in unobtrusive locations. No such area should be closer than 100 feet (30 m) from any housing unit, and no new housing unit should be further than 1,800 ft (600 m) from such an area. These areas are not to be included in land use intensity computations.

#### *Distance from Nonresidential Uses*

Various land uses and functions which are not compatible with a quality residential image may exist adjacent to the military housing site. Housing

must be screened or otherwise protected from these uses.

The distance from a dwelling unit to an expressway or major highway will be 150 ft (12 m). Buffer zones will be designated by the design division. Dwelling units should not front onto a major collector where traffic volume may present a hazard. Screening should be provided for safety, noise insulation, and visual privacy.

All housing units should be screened from adjacent disturbing activities by planting, fencing, walls, or earthworks designed to minimize noise and visual nuisance. Where a berm or grade separation exists, housing may be located so that all parts of the building are entirely within the sound shadow, providing normal yard considerations are met (Figure 38).

Where no sound shadow is created, housing units should be separated from the disturbing activity by at least 90 ft (28 m) (Figure 39). Screening and buffer zones should be provided between housing and all institutional and nonresidential uses.

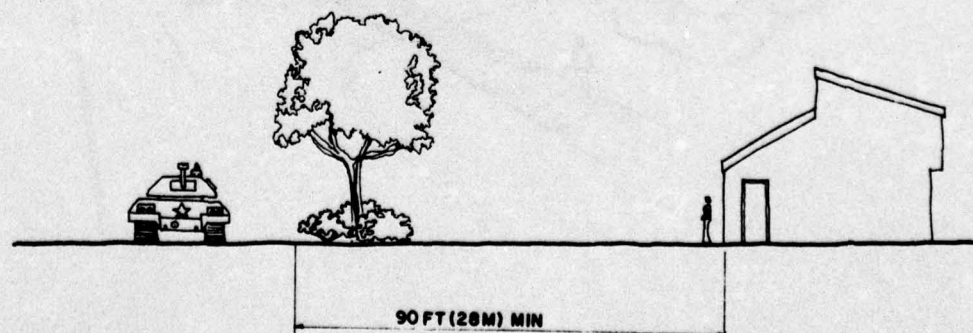
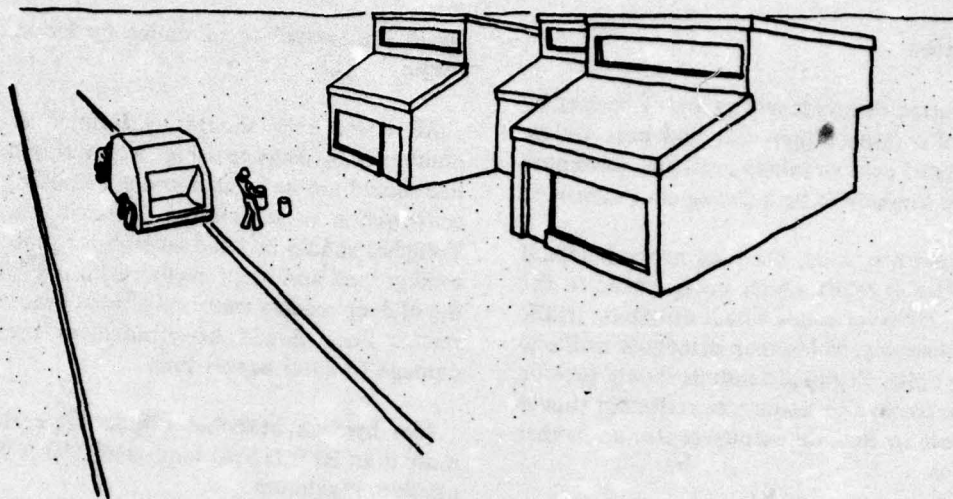


Figure 39. Activity/building separation.



**Figure 40. Individual trash disposal.**

#### *Trash Disposal*

If a method of individual trash removal is used, each unit must have its own receptacles (Figure 40). Since collection is on a unit-by-unit basis, vehicular access to or near the unit is required. The unit's garbage area should be near the kitchen but away from other habitable rooms and windows. Since each unit can be identified with its garbage, residents are more likely to police their own garbage areas.

If common disposal is used, a large common trash receptacle must be centrally located within the dwelling unit grouping (Figure 41). Only one vehicular access, therefore, is required. The receptacle need not be immediately adjacent to any one unit, but longer distances from the unit may cause litter to be dropped en route. The communal nature of this method may discourage individual policing of stray trash. The receptacle area must be visually screened from the dwelling units, open spaces, and streets.

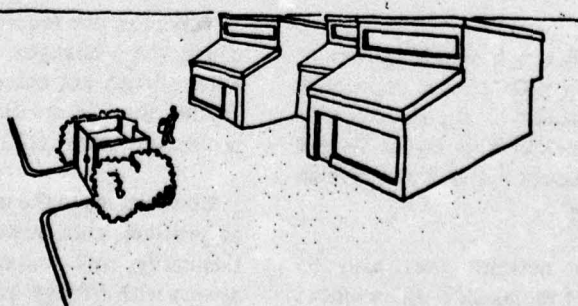
An individual unit-by-unit method, therefore, is preferred on the basis of neatness and individual maintenance.

#### *Outdoor Storage*

Outdoor storage of personal equipment should be provided for each dwelling unit. Storage design should consider the nature and location of activities that require equipment not normally kept within the dwelling unit. Carrying equipment through the unit or around the ends of long housing rows should be avoided by locating outdoor storage on the side of the unit where the activity is most likely to occur.

Outdoor storage should be located directly adjacent to the dwelling unit.

This storage space may be allocated to one location or divided between locations on different sides of the unit. If divided, each space must be large enough to accommodate the intended equipment.



**Figure 41. Collective trash disposal.**



## Transportation

Transportation demands will probably be met by two modes of transportation—car and bus. Unless the site is located near an existing rail line, passenger rail service is unlikely to be a strong consideration.

As previously discussed, the road network should consist of arterial roads which bring traffic to the housing site, collector roads which distribute traffic to residential streets, which then distribute traffic to the dwelling units. Regional arterials should provide access to the town, and major site collectors should provide access to the community center and other base facilities.

Bus service between the housing site and the town center or shopping center is highly recommended. If the housing site is large enough, a collector route through the site may be desirable. A regular shuttle or mini-bus service among neighborhoods and to the community center may also be desirable. If not, departure to town may be from a central location such as the community center. Bus shelters that are readily identifiable and compatible with the landscape and architectural character of the site should be provided at each stop. Seating should be provided, as should safety precautions such as lighting and surveillance.

## Utilities

### Water

The location of the feeder line will be supplied to the AE.

Feeder lines will bring the water supply to the housing site. Distribution mains will then distribute the water supply to service lines which take water to each dwelling unit.

The distribution main network should generally follow the street layout. The pipes should be located on one side of the street, usually in the right-of-way between the curb and sidewalk. This layout should result in the shortest distribution mains and service lines.

The distribution main network may also be located down the middle of the block if an easement is provided for access to the water line. Service lines then enter the units from the block interior. Mains

should be located to minimize feeder and branch length.

All water lines should be located so that the number of roadway crossings is minimized. A water line should not be located under a building or where construction of a building or paving is planned. Trenches should be deep enough for pipes to lie on solid ground and be protected from freezing. Planting of deep rooting trees and shrubs over mains and service lines should be avoided to prevent root damage to water supply lines.

Fire hydrant branches should preferably be no more than 50 ft (15 m) long, with 350 ft (90 m) the absolute maximum.

A looped grid layout is the most desirable for water distribution systems. Although dead-end mains should be avoided, where they cannot be, provisions should be made for blowing out by a valve or hydrant. Valves should be installed at intervals of approximately 5,000 ft (1524 m) along supply lines and 1,200 to 1,500 ft (365 to 457 m) along main distribution loops, feeders, and primary branches.

### Sewers

Connection points to the system will be supplied to the AE.

Sewer pipes should be located following the same general considerations used in placing water supply lines.

Sewer lines and water lines should not be located in the same trench and should be horizontally separated by 10 ft (3 m). If, however, this cannot be done, sewer and water lines may be located in the same trench if the water pipe is placed on a shelf of solid earth at least 1 ft (.3 m) above the sewer pipe.

Manholes are required at the end of a lateral or where slope changes. The distance between manholes should not exceed 500 ft (150 m) in sewers smaller than 18 in. (0.5 m) in diameter and should not exceed 600 ft (180 m) for larger sewers.

Connections to the units should have as few bends as possible; convenient rodding should be insured. Generally, unit sewers may be connected to other sewers with fittings, rather than through manholes. Manholes should, however, be provided if a connection is more than 150 ft (52 m) from a cleanout, if the

cleanout inside the unit will not be convenient for rodding, or if outside cleanouts are not feasible.

### *Storm Drainage*

The storm drainage system is designed to remove surface water to prevent unwanted ponding and flooding. Surface water from impervious surfaces and saturated soil must be collected, transported, and discharged in a way that will be safe and unobtrusive to the family housing environment.

The ideal storm drainage system is a completely natural system where no artificial construction is required. Although this will probably be impossible with the densities required for family housing development, the minimum of artificial drainage control should be sought. All natural drainage networks must be kept free from obstruction.

The storm sewer system consists of the drainage surface, open gutters and swales, inlets and underground piping, and a body of water into which surface drainage is discharged.

All ground should be of a grade that allows water to flow, but not so fast as to cause erosion. The grade depends upon the volume of water and the surface finish. Surface grading should be as follows:

Planted and broad paved areas	1 % min.
Streets	.5% min.
Ground around all buildings	2% min. for at least 10 ft (3 m) from building
Ditches and swales with tributary area less than ½ acre (2023 m²)	2% min., 10% max.
Ditches and swales with tributary area more than ½ acre (2023 m²)	5% min., 10% max.
Lawns and grass banks	25% max.
Banks with unmowed and undisturbed planting	50% max.

Any water running off of installation property onto adjoining property should drain only into properly engineered drainage courses.

Surface flow will usually begin to erode gullies within 500 ft (150 m) of its concentration. Hard-surfaced channels should be developed before this can occur. Drainage easements should be established to preserve unobstructed flow.

In street gutters water may flow 800 to 1000 ft (240 to 300 m) before an inlet to an underground pipe is required. The flow of storm water should never cross another street; inlets should therefore be located at the low corners of each block. Cul-de-sacs should flow into collector streets wherever possible to avoid the necessity of installing drainage systems at the closed ends. Drainage water should not turn sharp corners or be obstructed by protrusions into gutters.

Natural drainage patterns should be identified when laying out a storm drainage plan. Surface systems should be developed as far as possible and underground piping should be kept to the minimum practical length. Dwelling unit and yard run-off should drain toward residential street gutters or culverts. Drainage from residential streets should flow directly into collector street gutters. Underground piping should usually be located in the rights of way of collector streets and will pick up flow from gutter inlets. Larger undeveloped open spaces should drain through swales to either collector street gutters or directly into inlets to underground lines. Drainage from these open areas should never flow across yards or through clusters. Buildings, clusters, and yards should likewise never be developed in the path of natural drainage (Figure 42).

### *Electric and Phone*

Electrical and phone lines should be located underground to preserve a safe, uncluttered residential environment.

Electric lines may be located adjacent to streets or in block centers to avoid interference with buildings and paving. Telephone lines should be provided as part of the electrical distribution system, but should be completely independent of electrical cables.

Direct cable burial should be used wherever possible. Thick wall conduit, however, should be used under streets, walks, and other paving exceeding 5 ft (1.7 m) in width. Burial depth for cables rated in excess of 600 V should be at least 30 in. (0.75 m) and 24 in. (0.67 m) for cables rated at less than 600 V.



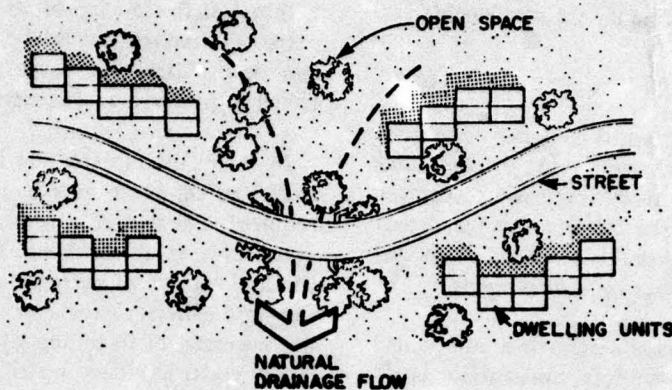


Figure 42. Surface drainage.

Transformers within the housing area should be installed on foundations and enclosed for safety. They should be screened to be as unobtrusive as possible.

#### Gas

Gas lines may be located in the same right-of-ways as other utilities. They should not be located in the same trench, however, since leaking gas collecting in other ducts or conduits could become an explosion hazard. Gas lines should not be located under buildings or paved areas or where construction of buildings or paving is planned. Gas lines should be looped within the housing site to eliminate dead ends.

Gas mains should be located at least 2 ft (0.6 m) below grade to accommodate any normal surface loads. Where manufactured gas is used, lines should be uniformly graded, providing drainage to low points to prevent condensation pockets. Where natural gas is used, lines may follow the natural contours of the site. Drips should be installed throughout the system to provide for blowing out the lines.

#### Community Facilities

The major community center will provide the major merchandise, service, recreational, cultural, religious, and social necessities of active and retired personnel and their families. Facilities in major community centers generally include main retail facilities, personal services, religious facilities, financial services, cultural activities, entertainment, food exchange, and visitor accommodation.

Within the housing site itself, however, residential service facilities may be provided if warranted by

population size. Such facilities might include post office substation; snack bar; vending machines for newspapers, cigarettes, and minor food items; meeting room or pavilion; bus or taxi shelter; child care center; administrative aid station; building management center; and fire station (if required).

The residential service center should be designed to provide convenient, compact layout of facilities and variety and interest within the neighborhood. It should be located within convenient walking distance of all residents and be accessible from the pedestrian walkway system. To avoid duplicating available services, it should not be located within convenient walking distance of the community center. If a large housing population or long walking distances (over  $\frac{1}{4}$  mile or 1200 m) dictate, a number of residential service centers may be required. These centers may correspond to defined neighborhoods within the site.

Safe, pleasant, and convenient pedestrian access to the residential service center is essential. Although pedestrian access should be maximized and encouraged, limited parking should be provided for customers as well as employees. Drop-off or standing lanes may satisfy this requirement. Access to the service center should be by collector streets only so the center does not generate traffic onto local residential streets. Delivery and trash removal should not interfere with pedestrian or vehicular circulation and should be screened and visually unobtrusive.

Landscaping of the residential service center should be planned to achieve an attractive setting and pleasant environment that harmonizes with the surrounding area.

An elementary school serving approximately 600 children should be located either within or directly adjacent to the family housing site. The school site should be a minimum of 10 acres (45 000 m<sup>2</sup>) with an additional acre for every 100 children enrolled. If a junior high school is required, the site should be 20 acres (81 000 m<sup>2</sup>) plus 1 acre (4047 m<sup>2</sup>) for every 100 students enrolled. Schools should be within convenient walking distance of the students' homes. Maximum walking distances should be approximately ¼ mile (1207 m) to an elementary school, and 1 mile (1609 m) to a junior high school.

### **Landscaping**

Landscaping is a functional element of housing site design, not just a decorative or cosmetic treatment. It contributes to residents' physical and psychological health by introducing humanizing elements. Planting provides shade, reduces noise and dust, controls erosion, and tempers heat, humidity, and wind. Landscaping also provides a means of boundary and spatial definition.

Natural vegetation should be preserved wherever possible, as the cost of replacing existing planting is unwarranted. In addition, the time required for replacement planting to mature to the state of existing vegetation is undesirable.

Existing landscaping can be expanded upon, used as a design opportunity, or used to augment special topographical features. Landscaping should complement the spatial design of the site and add color and beauty. Landscaping can divide functional areas and direct traffic and activity flow, as well as conceal unattractive structures and utilities.

### ***Design Principles***

Planting should impart an image of permanence to the greatest extent possible. Long-lived vegetation should be selected and spaced for ultimate growth. Short-lived vegetation with rapid growth should be used only where an immediate effect is essential or the space occupied will eventually be occupied by more permanent vegetation.

Planting layouts should be broad and simple to avoid excessive maintenance. Spotting of small isolated planting beds or numerous isolated trees should be avoided because large power mowing equipment cannot operate effectively in areas cluttered with such obstacles. Very small grass areas

should also be avoided in favor of a ground cover requiring less maintenance.

Over-planting should be avoided. Unnecessarily close spacing or needless planting in large areas is originally costly and perpetuates high maintenance costs.

Formal planting designs—trees in rows and geometrically trimmed hedges—require much maintenance and attention to attain an effective appearance. In addition, formalized planting may impart an especially undesirable image of regimentation. Informal or natural planting softens the impact and requires less maintenance. If plant losses occur, they are less conspicuous; plants can be easily replaced without lessening the impact of the design.

Tall growing materials should not be planted under windows as they require constant trimming and look unnatural. Tall or dense planting at street intersections where vision will be impaired should also be avoided.

Trees and shrubs must be properly balanced in terms of both immediate effect and ultimate design effect. Trees are generally more difficult to handle than shrubs in the original planting because their wide spacing and initial small size give little indication of their ultimate effect. Because shrubs have a considerable immediate effect, over-reliance on them often results. Properly selected trees, however, will ultimately give a greater effect than shrubs and will require less long-term maintenance effort. In addition, trees provide shade which shrubs cannot.

Deciduous shade trees are generally preferred over evergreens in most parts of the United States, except perhaps in tropical or subtropical regions. Deciduous trees admit solar radiation to dwelling units during winter months while providing screening during the summer. In year-round warm climates, evergreens provide the desired shade in all seasons. Evergreens also add greenness during winter months, thus alleviating the drabness of leafless deciduous vegetation.

The suitability of trees varies according to conditions imposed by the housing layout. Large groups of trees will usually have enough space to mature only in areas of low building coverage. In areas of medium building coverage, mass planting may be suitable only in green belts or buffer areas. Trees should not be planted in confined areas since the



continuous pruning required will result in an unnatural appearance and incur greater maintenance. In very confined situations, use of trees may be inappropriate and should not be forced. Landscaping may be achieved using shrubs, ground cover, mounding, or hard material.

Landscaping of parking areas is desirable to protect the car and soften the hard, paved image. Planting must be vigorous, tolerant of fumes and dry conditions, and give good shade. Trees with large leaves which may become slippery and those which emit an excessive amount of sap should be avoided as they could cause a potential hazard or damage an automobile's finish. Trees should have an adequate amount of undisturbed soil around their roots and the boles should be protected from car bumpers. Indiscriminate parking around trees should be prohibited as the compaction of the soil will eventually kill the tree.

Sitting areas in play lots for small children should contain trees for appearance, shade, and wind protection. Layouts and planting for these areas should be designed together, considering the tree's need for open soil, air, and water. Heavy pedestrian traffic around the bole of a tree may cause enough soil compaction to affect the health of the tree. Protection should be provided around the base of the trunk in a way that does not isolate the tree from the activity area.

#### *Special Design Considerations*

Proper surface drainage should be insured through grading; subsurface drainage should be installed during building construction. Preservation of existing vegetation is an important consideration in developing a grading plan.

Steep banks planted with grass may be difficult and expensive to maintain. A ground cover that requires no mowing and provides a strong root base should be used whenever possible. Where banks are unavoidable, the gradient should be minimized and the tops and bottoms of the banks rounded to prevent erosion.

Fillets with radii of 3 to 5 ft (0.9 to 1.5 m) will greatly reduce the wear on grass caused by pedestrians cutting corners at walk intersections. Edging of planted areas has an important influence on maintenance costs. Intricate patterns or edges of irregular materials should be avoided between planting and

pavement or between buildings and planting. Any edging requiring hand trimming should be avoided.

Trees and shrubs can attractively separate various functional areas. However, an effective screen of vegetation requires much more room than a fence or wall. Thus, where space limitations prevent the use of a planting screen, vines can be used to soften hard fencing materials.

Turf and planting are important elements in the control of dust and erosion. The most satisfactory cover vegetation for areas which are likely to be subjected to frequent traffic is a dense, tough, wear-resistant turf of adapted perennial low-growing grasses. Lawns subjected to occasional traffic do not require the same density or toughness. More quick-growing grasses can be used and the rates of seeding and fertilizing can be reduced. Nontraffic areas can be planted with a ground cover that is relatively easy to grow and maintain.

Dense foliage can absorb and deaden noise to some degree. Belts of planting can help protect areas of the housing site from undesirable outside noise and provide noise control within the site.

Barrier plantings of trees or high-growing shrubs form an effective protection from winds. Since summer breezes and winter winds generally come from different directions, properly locating the planting will allow free flow of summer breezes while blocking winter winds.

In addition to utilitarian purposes, proper planting greatly improves the appearance and enhances livability of the housing site by introducing variety and relieving bareness. Since planting intended solely for appearance is a considerable continuous expense, the full aesthetic potential of utilitarian planting should be maximized.

#### **Maintenance**

Maintenance of the family housing site should be included in the overall installation maintenance program.

Equipment used for housing site maintenance should be stored and repaired with the overall installation maintenance equipment rather than being separately accommodated on the housing site.

The residents' responsibilities should include minor repairs, cleaning, trash depositing, and policing. The residents' responsibility for yard maintenance contributes to their sense of personal space, privacy, and identity. Such responsibilities include lawn mowing, cleaning, and garden maintenance.

Storage accommodations for household maintenance equipment supplied by the residents should be provided within the dwelling unit and yard.

## **5 SITE CONCEPT PLAN EVALUATION AND REVIEW**

### **Design Evaluation Requirements**

In order for a proposal to be considered conforming to all requirements specified in the RFP, the proposer must display sufficient information to enable a complete evaluation. The RFP will delineate the material that must be submitted as part of the proposal.

Specifications should be provided for:

- a. Walks
- b. Streets
- c. Exterior utility systems.

An overall site plan should indicate:

- a. Street layout and widths
- b. Driveways
- c. Parking areas and arrangements
- d. Dwelling unit type and arrangement
- e. Dwelling unit yards
- f. Utility layouts and easements
- g. Site lighting
- h. Recreation areas, playgrounds, tot lots
- i. Natural site amenities
- j. Features to be retained or removed
- k. Landscaping
- l. Site boundary identification
- m. Site entrances or gates
- n. Pedestrian paths
- o. Existing and new topographical contours and retaining walls
- p. Ancillary facilities (if applicable).

A typical cluster plan should be submitted for each housing type indicating:

- a. Streets
- b. Driveways

- c. Parking, carport/garage locations
- d. Walks
- e. Spacing between units
- f. Typical grading
- g. Typical utility entrance into units
- h. Dwelling unit yard definition
- i. Outdoor storage
- j. Trash receptacles.

The RFP will provide specific information on required submittals. Such information will cover drawing scale, number of copies, drawing format, and engineering and supportive data.

Proposal evaluation will consider both technical quality and cost. The major technical evaluation areas, in order of descending importance are housing unit design, site design, housing unit engineering, and site engineering. The RFP will provide information concerning design and technical evaluation criteria and priorities.

Factors that will be examined for site design include:

- a. Street and block patterns
- b. Variety of unit setback and orientation
- c. Compatibility with surroundings and topography
- d. Privacy (unit spacing, fencing, landscape buffers)
- e. Recreation areas/open spaces/playgrounds/tot lots
- f. Preservation of existing desirable features
- g. Vehicular circulation (occupant and service vehicles)
- h. Occupant and guest parking (quantity, convenience, layout)
- i. Pedestrian circulation.

Factors that will be examined for site engineering include:

- a. Water system
- b. Sewer system
- c. Storm drainage (aboveground, underground)
- d. Gas system or oil supply
- e. Electrical distribution
- f. Paving (streets/driveways/walks/patios)
- g. Grading
- h. Grassing and soil treatment.

The following outline indicates more specifically the design attributes of a site concept plan that may



be examined in depth during the evaluation of proposals.

**a. Access and Circulation**

**1) Accessibility**

- a) accessibility to regional highway
- b) accessibility to \_\_\_\_\_

**2) Roads**

- a) alignment
- b) approaches, views
- c) traffic generation on residential streets
- d) street widths: collector  
residential
- e) intersection safety
- f) definition of circulation hierarchy
- g) total paving area
- h) natural drainage obstructions
- i) solution of circulation requirements
- j) accommodation of snow removal
- k) cul-de-sac layout: collector "dead end"
- l) through street appearance
- m) overall image quality
- n) loop street: block size
- o) block interior space utilization
- p) overall image quality
- q) p-loop street: block size
- r) block interior space utilization
- s) overall image quality
- t) curvilinear street: block size
- u) block interior space utilization
- v) overall image quality
- w) grid layout: block size
- x) block interior space utilization
- y) overall image quality

**3) Paths**

- a) pedestrian accessibility
- b) solution of circulation requirements
- c) activity conflicts
- d) quality of attraction
- e) path identity
- f) gradient
- g) pedestrian street crossings
- h) bicycle utilization of streets
- i) appropriate use of materials
- j) overall image quality

**b. Neighborhood Concept**

**1) Neighborhood identity**

**c. Housing**

**1) Natural Considerations**

- a) units with favorable solar exposure
- b) units with favorable wind exposure
- c) units affected by ice hazard

- d) units affected by fog hazard
- e) units disrupting natural drainage

**2) Housing Variety**

- a) housing mix: single units  
duplex units  
townhouse units

**3) Cluster Arrangement**

- a) variety of setbacks
- b) yard depth
- c) privacy zone depth
- d) units' proximity to parking
- e) parking proximity to street
- f) favorable location of outdoor storage
- g) favorable location of garbage receptacles
- h) number of units in cluster
- i) overall image quality

**d. Recreation/Open Space**

**1) Tot Lots**

- a) area
- b) favorable proximity to housing units
- c) adequate shade
- d) provision for adult supervision
- e) overall image quality

**2) Active Open Space (Playgrounds)**

- a) area
- b) favorable proximity of housing units
- c) overall image quality

**3) Cluster Semi Common Area**

- a) area
- b) identity
- c) overall image quality

**4) Installation Facilities**

- a) favorable proximity of housing units

**e. Landscaping**

**1) Natural Amenities**

- a) preservation of amenities
- b) integrity of preservation

**2) New Landscape Design**

- a) immediacy of impact
- b) provision of shade
- c) integration into overall design
- d) microclimate advantages
- e) overall image quality

**3) Buffer Landscape Usefulness**

**f. Community Facilities**

**1) Community Center**

- a) favorable proximity of housing units
- b) pedestrian accessibility

**2) Residential Service Center**

- a) favorable proximity to housing units
- b) pedestrian accessibility
- c) market overlap
- d) distance to vehicular access
- e) landscape quality

- f) overall image quality
- g. Fire Protection
  - 1) favorable proximity of units to fire station
  - 2) favorable proximity of hydrants to units
- h. Security
  - 1) parking area surveillance
  - 2) yard surveillance
  - 3) open space surveillance
  - 4) path surveillance
  - 5) other
- i. Utilities
  - 1) unobtrusiveness of utilities
  - 2) usage of easements
  - 3) ease of repair
- j. Transportation
  - 1) accommodation of bus service (if appropriate)
  - 2) accessibility to community center
  - 3) accessibility to residential service center.

#### **Design Reviews**

Following the selection of a winning proposer and the completion of the contract documents, the turn-

key contractor will receive a notice to proceed on the development of all final construction documentation. Reviews shall be held in the offices of the design district at the 50 percent and 100 percent completion stages. Dates and details of these reviews will be delineated in the RFP documents. Such documentation should include all site analysis material, design documents, engineering drawings and calculations, specifications, and supportive data for:

- a. Demolition, clearing, and grubbing
- b. Excavation and fill, grading
- c. Storm drainage
- d. Vehicular paving
- e. Pedestrian paving
- f. Sanitary sewer
- g. Water distribution
- h. Gas distribution
- i. Retaining walls and steps
- j. Landscape and planting
- k. Street furniture, equipment, markings.



## APPENDIX:

### LAND-USE INTENSITY STANDARDS

The following LUIs are acceptable (see Figure A1)\*:

Target	Acceptable Range		
	Enlisted Men and Company Grade Officers		
4.1	4.0 to 4.5	5.5	Minimum LUI for 2-bedroom units in urban and metropolitan areas
4.6	Minimum LUI for 3-, 4-, & 5-bedroom units in urban and metropolitan areas	3.2	Field Grade Officers
		3.7	3.0 to 3.5
		4.5	3.5 to 3.9
			Minimum LUI in urban and metropolitan areas
			Colonels
		3.0	
		4.5	Minimum LUI in urban and metropolitan areas

\*Construction Criteria Manual, DOD 4270.1-M (Department of Defense, October 1973), p 16-4.

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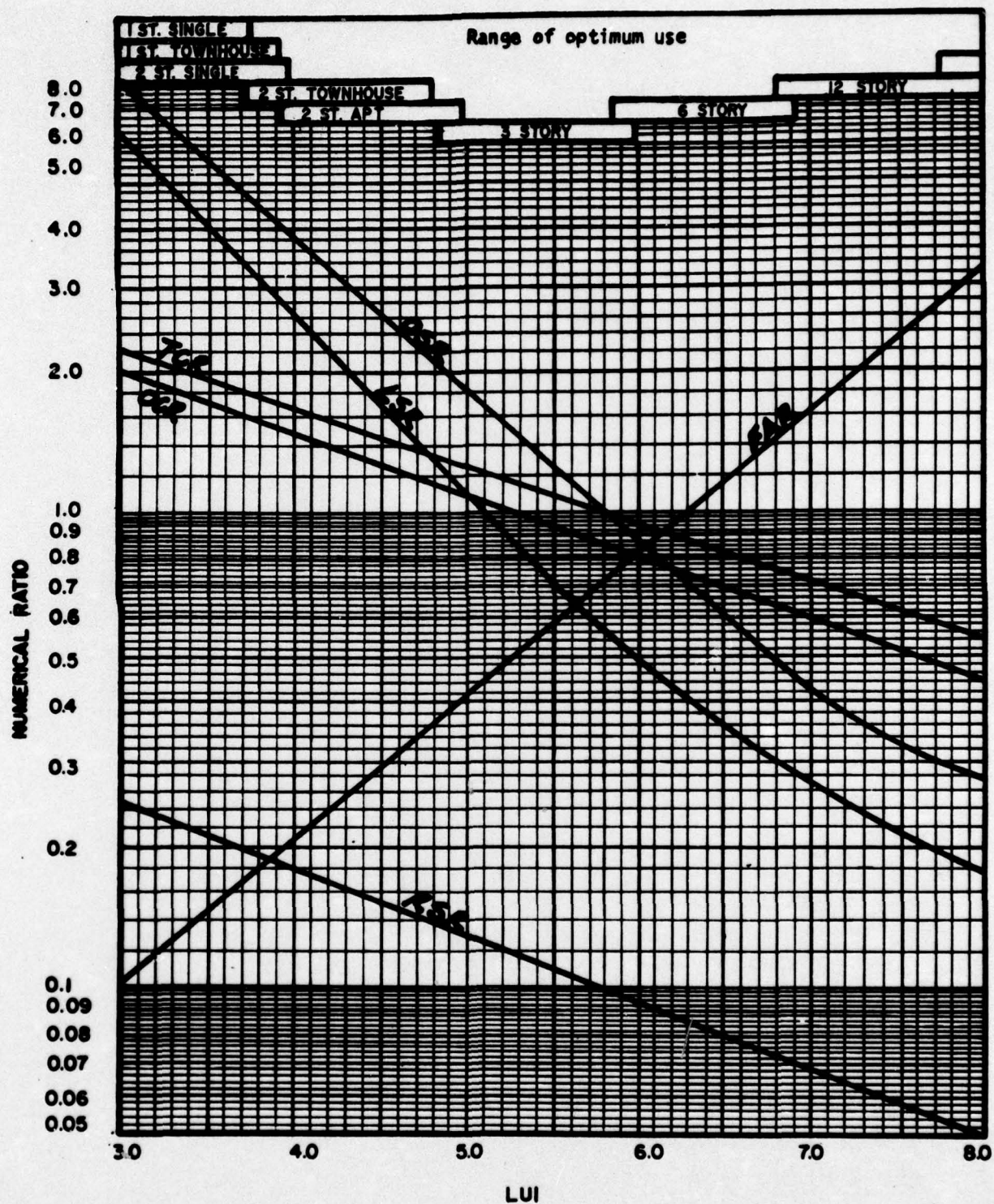


Figure A1. Land use intensity.



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